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PRELIMINARY EDITION FOR TECHNICAL CRITICISM

PATTERNS OF RESOURCE USE

A TECHNICAL REPORT
PREPARED BY THE INDUSTRIAL SECTION
UNDER THE DIRECTION OF
GARDINER C. MEANS

SUBMITTED BY THE INDUSTRIAL COMMITTEE
TO THE
NATIONAL RESOURCES COMMITTEE

UNITED STATES GOVERNMENT PRINTING OFFICE - - - - - - WASHINGTON, D. C

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National Resources Committee
North Interior Building
Washington

February 10, 1938.

Mr. Frederic A. Delano,
Chairman, Advisory Committee,
National Resources Committee,
Washington, D. C.

My Dear Mr. Delano:

We are transmitting herewith a report on constructing "Patterns of Resource Use," prepared by Dr. Gardiner C. Means and the Industrial Section. Our Industrial Committee has conferred with Doctor Means as this report has been developed, and we believe that this type of approach may have great value as additional background in the development of national policy in respect to the use of resources.

We recommend that the report be circulated, confidentially, for criticism among economists, statisticians, and other specialists, so that such criticism may be available to this Committee before it is published for general circulation. We recognize that this is a new field of investigation, and present these initial results with full appreciation of their incompleteness and the possibility of a variety of interpretations as to their meaning and significance. We hope that further analysis and public discussion will clarify and augment the usefulness of this report.

Sincerely yours,

Isador Lubin
Thos. C. Blaisdell, Jr.
Lauchlin Currie
Gardiner C. Means

Leon Henderson
Mordecai Ezekiel
Harry D. White
Charles W. Eliot, 2nd

NATIONAL RESOURCES COMMITTEE
NORTH INTERIOR BUILDING
WASHINGTON

March 4, 1939

The attached technical report on Patterns of Resource Use has been printed in a preliminary edition for technical criticism. The National Resources Committee has authorized this preliminary publication of the report, because it suggests new and potentially significant methods of study and analysis of major economic problems. It is the desire of the Advisory Committee to receive criticism and suggestions concerning the document so that they may be considered in any revision of the report and in connection with related work of the Industrial Committee.

An earlier draft of the report was circulated to a small number of economists, statisticians and other specialists as recommended by the Industrial Committee in February 1938. The resulting suggestions were considered in revising the report to the form now presented for more widespread technical discussion. Your comments on the report would be appreciated before October 1.

Sincerely yours,

Frederic A Delano

Frederic A. Delano
Chairman, Advisory Committee

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ACKNOWLEDGMENTS

The general approach and the basic concepts set forth in this report are the product of group analysis carried on by Gardiner C. Means, Gustav Seidler, and Victor von Szeliski and contained in an unpublished technical memorandum. The statistical procedures employed in the separate industry analyses are based to a major extent on the simplified graphic correlation techniques developed by Louis Bean of the Department of Agriculture, but also involve the use of numerical methods of correlation.

The body of the report was prepared by Gardiner C. Means. The final form of appendix 1 was prepared by Louis J. Paradiso, who also prepared appendix 2 and who was directly responsible for the statistical analysis contained in the report.

Acknowledgment is also due to Victor von Szeliski, who prepared the first draft of appendix 1; to A. J. Nichol and William Hurwitz, who contributed in the early stages of the study; and to William R. Muench, who supervised the numerical computations.

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I. INTRODUCTION

Under prevailing technical conditions, what is the level of economic activity which would absorb practically all of the great army of unemployed? What would be the market for commodities and services, industry by industry, at such a level? Is it possible to lay a foundation for answering these questions through the discovery of continuing relationships between such factors as employment, production, and consumer income? On the basis of such relationships can coherent patterns of resource use be developed which would show for the different parts of the national economy the volume of production and employment most likely to arise at any given level of national activity? These are the questions to which this report is addressed.

Any inspection of the detailed operations of the American economy reveals a constant state of flux. Tremendous changes in production and in prices take place even in very short spans of time. The whole level of production and of price can rise or fall while cross-currents of change can lift one industry and lower another. Over longer periods of time, totally new industries emerge, while old established industries disappear. New methods of production arise and destroy the value of displaced equipment and new wants call for new types of productive activity. The business man is constantly being called on to adjust to rapid changes in his market, his sources of raw material, and in the prevailing practices of business. Constant change seems to be inherent in the economic process.

Yet underlying this constantly changing activity there appear to be economic relationships of a continuing character. Specific changes do not occur independently of all others. In the highly complex structure of modern industry, changes of activity in the different parts are necessarily interrelated to a greater or less extent. The system of interrelationships among such changes constitutes the basic economic framework which conditions and limits specific economic activity.

This report is concerned with the characteristics of this basic economic framework. It presents evidence that continuing economic relationships do exist; it indicates techniques for discovering these economic continuities; it shows how these continuities can be used as a basis for developing coherent patterns of resource use which are consistent with the basic economic framework; and finally, it presents the results of an initial attempt to construct such patterns.

The main purpose of this report is to indicate the value of discovering the underlying continuities and to suggest that it warrants persistent efforts to measure these continuities more precisely than has been possible in connection with this report. Little more has been attempted than to show the usefulness of starting with an over-all view of economic activity, breaking down this activity into its separate components, and applying techniques of analysis which are suggestive of the methods by which underlying continuities can be measured. Yet the gross results arrived at, even with imperfect techniques and with faulty and inadequate data, are sufficiently useful to point the direction in which economic development is probably going to move. They do not furnish the basis for forecasts, but they do indicate the points at which expansion would be called for if productive activity were to increase. They indicate that the increased expenditure corresponding to an increase from 60 to 90 billion dollars in the total income received by consumers would call for virtually no increase in the number of persons engaged in agriculture. It would necessitate roughly a 40 percent increase in manufacturing employment, something more than a 50 percent expansion in the extraction of minerals, and an even greater increase in employment on the railroads.

The materials contained in this report should be used with great care since they are of an initial and experimental character. In order to cover the whole national economy it has been necessary to include some analyses which are far from satisfactory. Their inclusion can only be justified on the ground that it would be impossible to present the whole if any significant parts were missing. The American economy has been divided into 81 industries or industry groups and, as a first approximation, continuing relationships have been discovered in the case of most of these industrial segments. Many of these analyses probably have a high degree of validity, but some are far from reliable either because of inadequate data or faulty analysis. It is hoped that constructive criticism from specialists in each line may lead to the discovery of more valid relationships.

In the appraisal of the tentative patterns of resource use which are presented in this report, it should be clearly recognized that they do not represent operating programs. They lack the necessary precision and reliability for this purpose. Rather they constitute background information in the light of which individual producers or industries can formulate their own operating programs and assist in the development of more effective national policy.

It should further be recognized that these patterns of resource use presuppose no radical changes in the ways of doing business, in the factors which make for income distribution, or in the conditions under which individuals spend their money. The calculations assume that the techniques of production and distribution in the near future follow much the same course of gradual evolution that they have shown in the past, that significant variations in income distribution arise only from secular and cyclical developments, and that consumers continue to be free to spend their money as they choose. This means that so far as technology is concerned, the patterns set forth do not represent ideal use of resources but only the use that is likely to arise in the immediate future at different levels of economic activity.

Such patterns relate only to one of the desirable conditions of resource use which might be considered, namely, that involving full employment of available manpower. Since the patterns actually presented in this report are derived from data on economic behavior in an unstable economy, it is probable that they in turn represent unstable conditions. Likewise, the patterns presented in the report contain implicit in them the inefficiencies in the present economy which result from the failure to use the best available techniques, from the duplication of effort, and from competitive wastes. The more desirable objective in the use of resources would be one which involved not only full, but stable and efficient use of resources.

The emphasis on full use of manpower to the exclusion of the problems of stability and efficiency seems justified both on practical and theoretical grounds. Practically, the economy is today so far from using its manpower to the full that stabilization at current levels of production would be undesirable. Increases in productive efficiency tend to aggravate the problem of economic adjustment by adding technological unemployment to unemployment arising from other causes instead of expanding the total volume of goods and services produced. As full employment is approached, the problems of economic stabilization at a high level of employment and of increasing productive efficiency will become problems of the first order of importance. Futhermore, the development of patterns of resource use related to full employment is an almost necessary step to the development of patterns representing full and stable use of resources. An analysis of the former should point to elements of instability and lead to the creation of patterns representing greater stability. The problem of increasing efficiency in the use of resources is by its nature one for slow and continuing study and action.

The patterns developed in this report do not represent forecasts of what is going to happen in the future, they only attempt to set forth various combinations of happenings which are consistent with each other. Each pattern is concerned with a particular level of activity and aims to represent the consumption and the employment in each major industry which would be consistent with activity in other parts of the economy at that level. A pattern of resource use would be obviously inconsistent if it showed a high level of automobile production and a negligible production of steel or a high level of shoe production and no leather production. Valid patterns must show not only a consistent relation between the production of such things as steel and automobiles or leather and shoes but also a consistent relation between such apparently unrelated items as shoe production and automobile production or between shoe sales, passenger traffic on the railroads, gasoline consumption and school attendance. Each particular pattern thus interrelates activities in each part of the economy with activities in other parts.

The procedures and patterns set forth in this report are essentially different in character from those developed in other pioneer studies in this field. The basic difference between this report and the Brookings Institution Reports on America's Capacity to Produce and America's Capacity to Consume [1] as well as the Report of the National Survey of Potential Product Capacity [2] are indicated in a later chapter. At this point it is sufficient to point out that the findings of the several studies are not comparable since they aim to measure different things.

As the validity of this whole report rests on the existence of essential continuity underlying economic activity, the report takes up first evidences of the existence and character of continuities in our economy. It then shows how the knowledge of continuities can be used to construct patterns of resource use. And finally, it presents a series of crude patterns indicating the level of activity, industry by industry, which would be consistent with different levels of national activity. Such patterns can serve as additional background for the development of national policy.

---

[1] Leven, Maurice; Moulton, Harold O.; and Warburton, Clark: *America's Capacity to Consume*, Brookings Institution, 1934.

[2] New York Housing Authority; *Report of the National Survey of Potential Product Capacity*, 1936.

II. EVIDENCES OF CONTINUITY

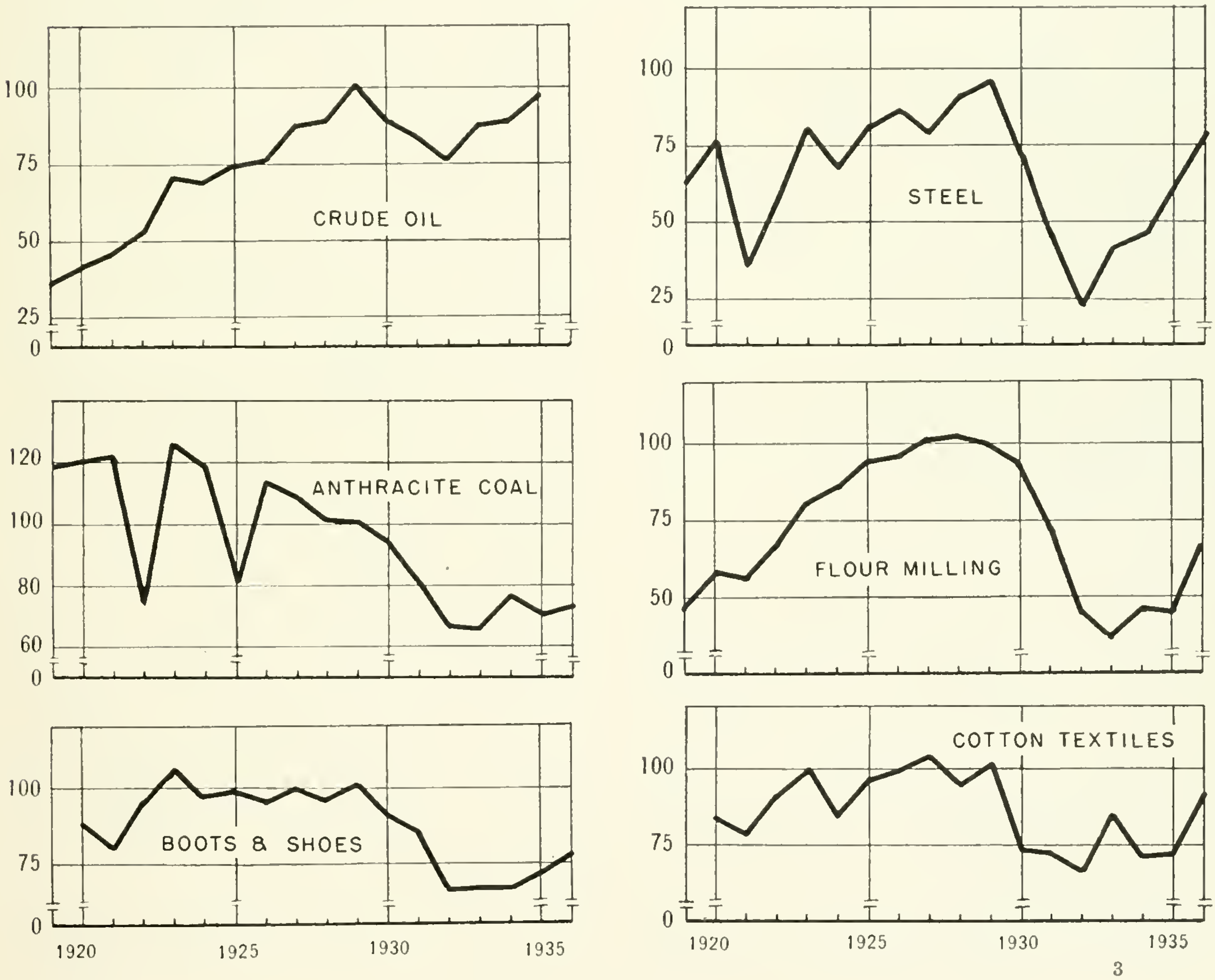
The construction of patterns of resource use depends, as has already been indicated, upon the existence of continuities in economic behavior underlying economic activity. At first glance, examination of the available data on economic activity does not disclose any considerable degree of such continuity. In nearly every industry, indexes of production, consumption, and employment show wide fluctuations from year to year. Charts I, II, and III reveal, for sample industries, the irregular ups and downs during the past 15 years. From these surface data the conclusion might easily be drawn that there are no continuities in economic behavior.

Yet a more careful study of industrial data reveals

CHART I

EXAMPLES OF VARIETY IN PRODUCTION BEHAVIOR

INDEXES OF PHYSICAL PRODUCTION
1929 = 100

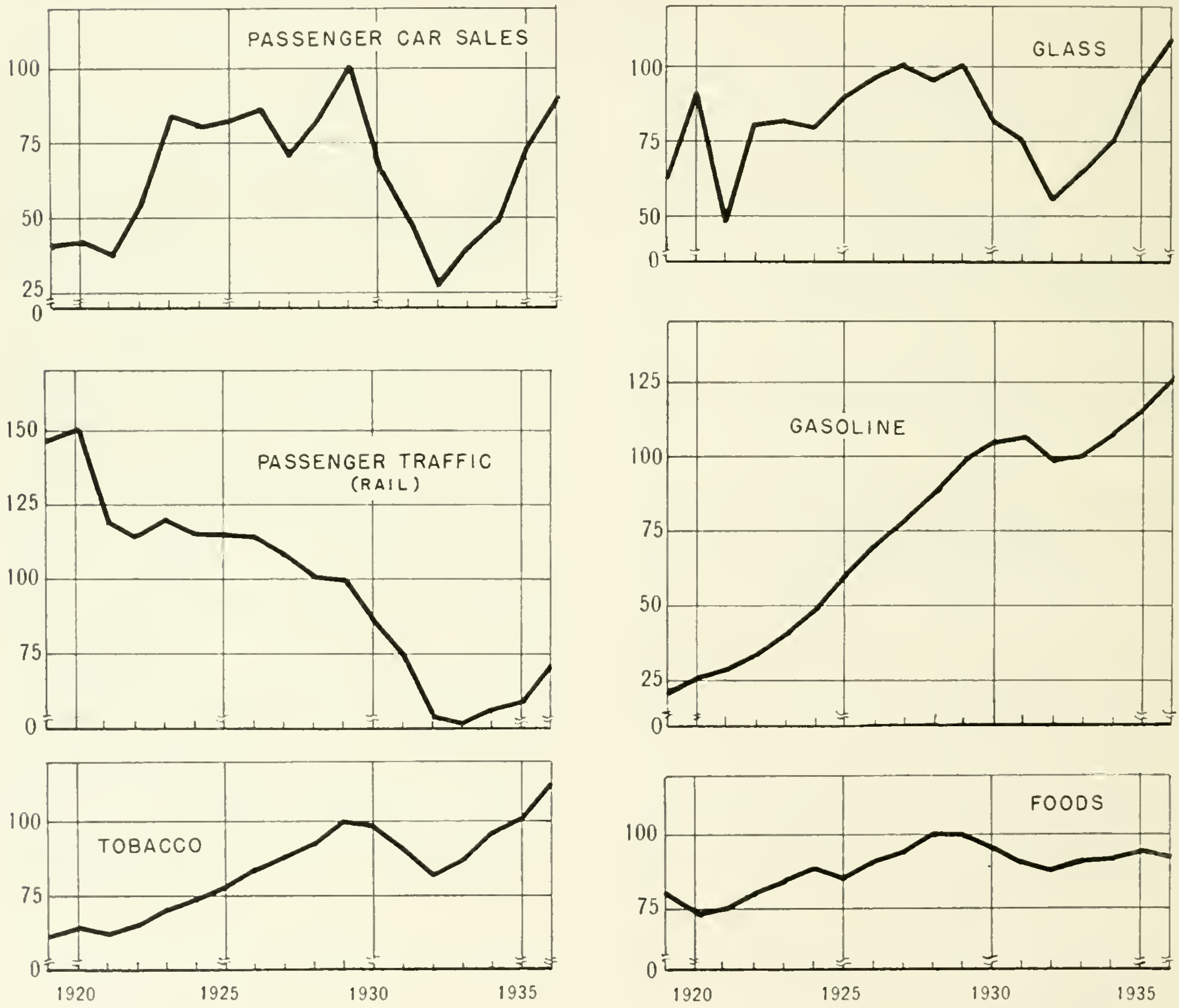


relationships which indicate very real continuity beneath these surface changes.[1] In most industries, consumer purchases and volume of employment and of production are each found to bear a fairly constant and determinable relationship to other major factors either

CHART II

EXAMPLES OF VARIETY IN CONSUMPTION BEHAVIOR

INDEXES OF CONSUMPTION
(1929 = 100)



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[1] Economic continuity may be said to exist for a particular category of economic behavior such as the buying of shoes or the employment of workers if, in this category, the economic behavior of people in the aggregate is a simple and continuous function of time and of any general or specific factors relevant to the particular category. This means that for such an item as shoe consumption, economic continuity is present if, (1) shoe consumption remains constant or changes only gradually through time when the relevant factors such as consumer buying power and price remain constant or, (2) shoe consumption changes to a degree related in simple fashion to the change in the relevant factors including time. Just what constitute the relevant factors in any particular case will depend on the particular type of behavior being considered. The condition of a simple and continuous function is met, so far as this report is concerned, if a relationship can be stated by a formula representing an arithmetical combination of straight lines, simple exponential curves or other simple curves such as a parabola.

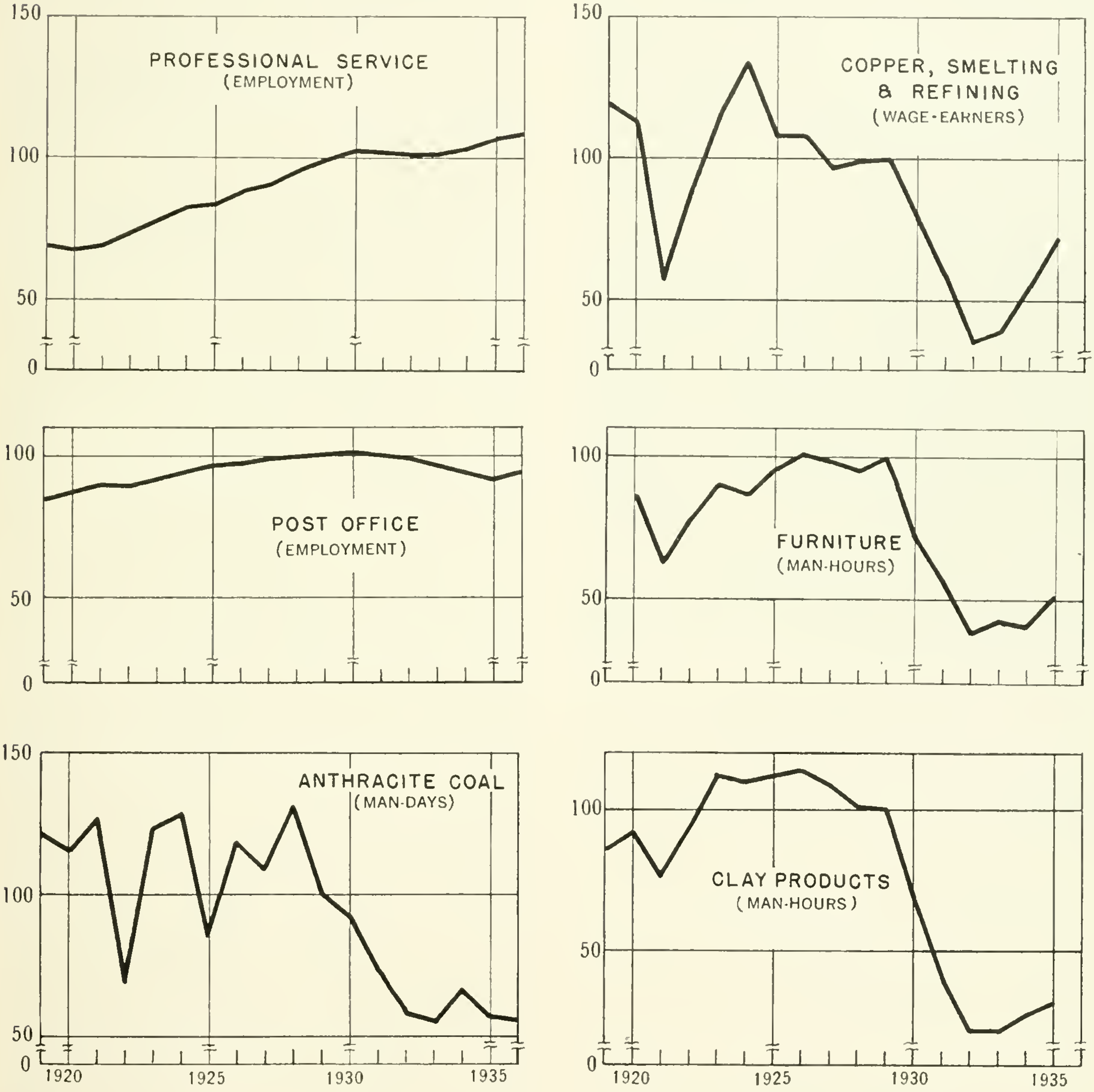
in the particular industry or in the economy as a whole. In each case, the factors which are of major significance have to be separately determined industry by industry. The relationships of consumption or employment to other factors may vary from a simple correspondence to very complex interrelationships changing gradually through time. In the following pages, examples of continuity in employment and in consumption are given,

CHART III

EXAMPLES OF VARIETY IN MANPOWER USED

INDEXES OF MANPOWER

(1929 = 100)



ranging from the very simple to the more complex and showing the existence of continuity underlying the year to year fluctuations in economic activity.

Continuity in Employment Relationships

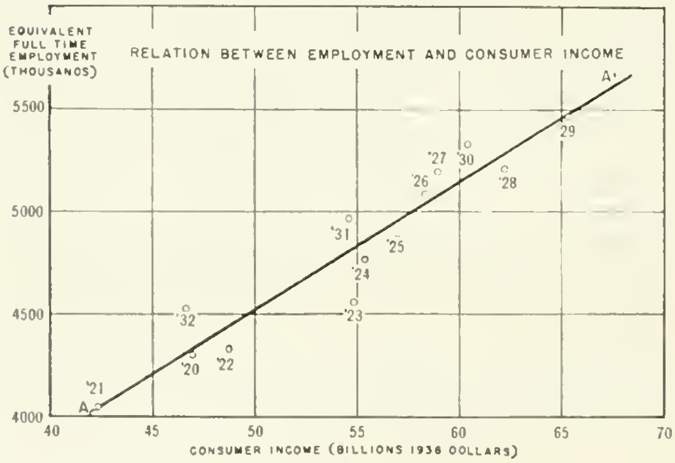
A very simple case of continuity is to be found in the stable relation between employment in retail distribution and the income received by consumers which is available either to be spent on consumption or to be saved. This is shown in chart IV in which employment for each year is plotted against the corresponding consumer income.[2] The relation between the two appears to be unusually simple, having remained almost unchanged from 1923 to 1932. The manpower necessary to distribute commodities which corresponds to a given level of consumer income appears to have been nearly constant. This relatively stable relationship between employment in retail trade and consumer income is approximated by the line AA′.

Comparison of employment in retail trade and consumer income as set forth in the chart brings out a second fact of significance, namely, that the relation between them has not been a direct 1-to-1 relation. Employment appears to have increased less rapidly than consumer income as both increased. A doubling of consumer income would have corresponded with much less than a doubling of employment in retail trade within the range of observation covered by the chart. Thus, it is possible not only to say that employment in retail trade and consumer income move up and down together but to indicate the exact way in which they are related and that this relation has continued to be constant through an appreciable period of time.

CHART IV

RETAIL TRADE — MANPOWER

1921 - 1932



This relation remained so nearly constant throughout the period that if only the consumer income arising in one of the years covered were known, it would be possible to calculate approximately the volume of employment in retail trade which would correspond. Thus, if one had known only that consumer income in 1923 was 54.8 billion dollars (in 1936 dollars), one could estimate the retail employment in that year by reading off on the chart the employment corresponding to such an income as indicated by the line AA′. This would give a figure of 4,800,000 as the estimated employment in retail distribution, an estimate within 5.6 percent of the actual employment. Yet 1923 was the year in which the relation between retail employment and consumer income was most out of line. For any other year covered, the error in making such an estimate would have been less.

Employment in the cotton textile industry presents a somewhat more complex case of underlying continuity. In this case the continuity involves a continuing rate of change through time. There is a clear relation between employment and production in this industry but the relation changes through time. When production and employment are plotted, as in the first panel of chart V, only a rough relation between the two is apparent. However, when a line AA′ is drawn passing through the data for any one of the years and representing roughly what might be expected to be the relation between different levels of production and employment in that year, examination shows at once that the data for other years bear a fairly uniform relation to that line. Thus, if such a line is put through 1926 the data for all except one of the earlier years lie uniformly above it and those for later years lie below it. Also the tendency is for the earliest years to be further above and the latest years further below this line. The fact that the points for successive years drop in relation to the line AA′ indicates a fairly steady decline in the employment required for a given amount of production in successive years. This is brought out in the second panel of the chart which shows for successive years the distance between the actual data for each year as plotted in the first panel and the line AA′. The line BB′ represents the declining trend. In this case the two factors, volume of production and a time trend, in combination parallel most of the variation in employment. Continuity shows itself in a relation between production and employment which changes gradually, but smoothly, through time.

A formula to express this relation between production, employment, and time can be worked out by standard statistical methods, discussed in detail in the appendix. The relationships found by this method are represented by lines AA′ and BB′ of chart V. Since it would take a three-dimensional figure to show the three-way relation between production, employment, and time, the chart can only show the relation between two of the items at a time while the other is held constant. BB′ shows the decline in employment which presumably would have occurred if production had been maintained constant throughout the period at the level of 1926 but technological improvement had occurred at the rate it actually did. AA′ shows the relation between employment and production for a single year in time, namely 1926.

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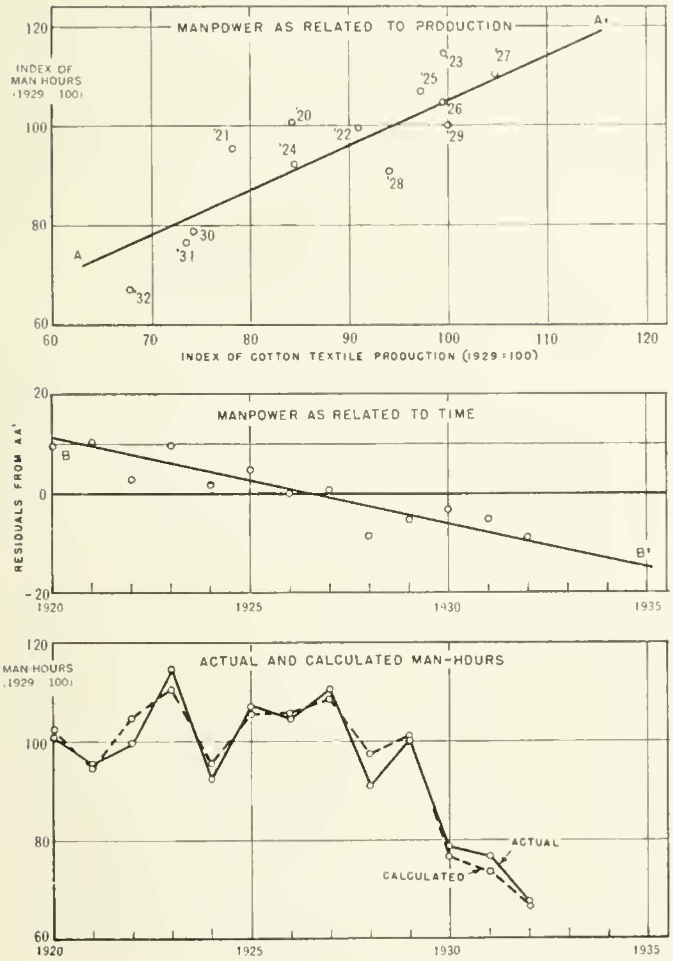
[2] Throughout the remainder of the report, the term "consumer income" will be used to refer to the real new buying power received by consumers as income in the time period being considered. In the statistical analyses, the figures used for consumer income are obtained by taking the estimated money incomes received by individuals exclusive of transfers and adjusting for changes in cost of living. The resulting index is necessarily crude but is practically useful.

From the formula or from the lines AA′ and BB′ in combination, it is possible to calculate the employment for any particular year if only the production for that year is known. The third panel of chart V shows the actual employment in each year and the employment calculated from the formula on the basis of actual production in each year. It can be seen that the calculated figures are very close to the actual. The difference between the actual and calculated values averages less than 2.7 percent of the average employment for the period. The smallness of this difference shows the essential continuity in this underlying relation between production, employment, and time in the cotton textile industry.

CHART V

COTTON TEXTILES

MANPOWER AS RELATED TO PRODUCTION AND A TIME TREND 1920 – 1932



A still more complex case is to be found in the mining of bituminous coal. Here, three factors beside employment are involved—production, time, and the average size of mine operated. These three items in combination parallel most of the variation in employment. Again, a formula can be derived to represent the relation between these three items and employment. Chart VI shows the actual employment from 1918 to 1934 and the employment calculated from such a formula by introducing the actual figures for production, year, and size of mine. Again, the closeness of fit bears evidence pointing toward an underlying continuity in relationship

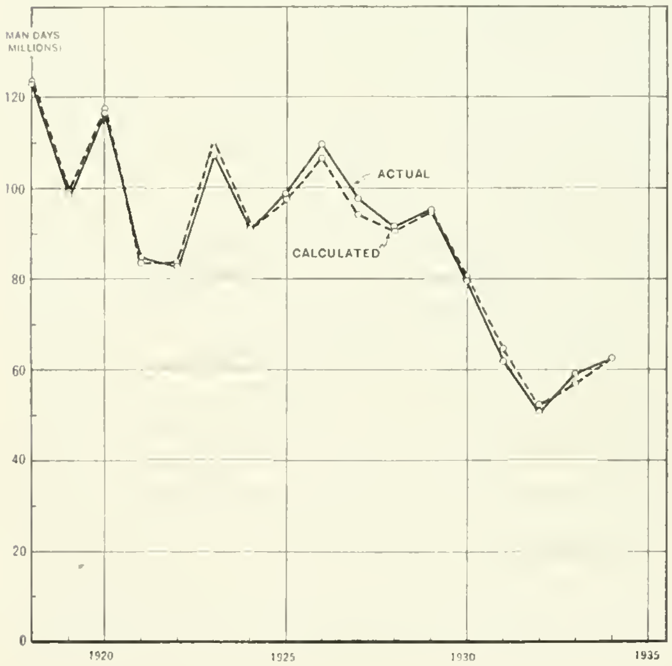
The above examples have been selected largely because reliable information on these industries is available. For many other industries, if not the bulk of all industries, the same underlying continuity exists, as is shown by the many examples discussed in the next chapter.

In respect to employment, one item deserves particular consideration. It is often thought that improvements in technology, because of their unpredictability, must add a serious element of discontinuity in the relation between production and employment. For the individual plant, there can be little doubt of this discontinuity. A newly developed technique or invention is introduced into a plant and perhaps 10 men are suddenly able to do the work of a hundred, so that there is a sudden shift in the relation between production and employment. But for industry as a whole, the introduction of new techniques is rarely an overnight

CHART VI

BITUMINOUS COAL – MANPOWER

ACTUAL MANPOWER AND MANPOWER AS CALCULATED BY MEANS OF A FORMULA BASED ON PRODUCTION, SIZE OF MINE, AND TIME



development. More likely, a single enterprising concern introduces the new technique on a commercial scale in a single plant. A year or more of adjustments and testing goes on. As the new technique proves successful, it is gradually adopted in other plants until at the end of a decade or more the new technique has been adopted throughout the bulk of the industry. Byproduct coke ovens have not yet displaced all of the beehive ovens, yet they have been in commercial operation for over 44 years. The first successful continuous strip rolling mill was built in 1926, yet 50 percent of the 1936 output of cold rolled wide strip and sheets was produced by the much less efficient hand mills or conventional mills. Even within the individual plant, there is usually substantial continuity because technological development takes place machine by machine and department by department, and because good management dictates that changes should be introduced slowly to avoid a disruption of morale. Thus, when we deal with the figures of an industry as a whole and often for single enterprises, new techniques throw their shadows before them. It is for this reason that the effect of inventions can be reflected for an industry as a whole as a gradual trend of increasing efficiency. This gradualness in the adoption of new techniques is an essential element in the continuity of relationships underlying employment.

Continuity in Consumption Relationships

Once it is recognized that the impact of technical improvement on an industry as a whole is gradual, it is not surprising to find continuity in the relations between employment, production, and other factors. However, there is a belief on the part of many analysts that no such continuity underlies the way people spend their money. The ups and downs of sales for different commodities and the unpredictability of the expenditure of individuals has led many to believe that, for the Nation as a whole, there is no discoverable continuity underlying consumption. However, analysis of the consumption of the products of particular industries seems to belie this idea. For industry after industry, an essential continuity appears to underlie consumption.

In order to see this situation clearly, it is necessary to clear away certain misleading ideas about the role of price. It is customary to consider variation in consumption as largely dominated by price and to expect that price variation must play a significant role in accounting for actual variations in consumption. While this appears to be true for most agricultural products and for some other products, it does not appear to be true for the bulk of industrial products in the post-war period. For a great number of items, variation in price does not appear to be the most significant factor in accounting for variations in consumption. Several elements enter into the explanation of the secondary significance of price.

In the case of some commodities like sulphur and nickel, practically no changes in price have occurred in recent years so that actual variation in consumption cannot be accounted for by variation in money price. However great the change in consumption might have been if the price had been changed, historically no change in price occurred, and therefore there was no change in consumption due to a change in price.

For a second group of items such as asphalt, cement, brick, and pig iron, prices in recent years have been relatively stable so that the influence of price changes on consumption has been of secondary importance compared to that of other factors.

For a third group of commodities, a moderate variation in price appears to have little effect on consumption. Gasoline is an outstanding case. Practically as much gasoline will be used at 16 cents a gallon as at 12 cents. The other costs of operating an automobile are sufficiently great and the character of its use is such as to make an extra 4 cents per gallon a secondary consideration in most cases of automobile use. Thus, while a lower price for gasoline would undoubtedly increase the consumption of gasoline, the increase is likely to be of secondary importance within the range of gasoline prices that are likely to arise. Another case where even fairly wide variations in price are of secondary importance is that of tin. The major use of tin is in the making of tin cans. Yet tin is a secondary element in the cost of tin cans, while the consumption of tin cans is more influenced by the price of fruits and other foods available for canning than by the price of cans. As a result, the consumption of tin is little affected by variation in its price.

In the case of another large group of items, price changes only gradually through time, steadily increasing or decreasing. When this type of price change occurs, the influence of price change is likely to be intermixed with the influence of other factors operating through time. A trend showing changing consumption through time may thus account for the influence of a variety of factors including price.

Finally, there is a large group of items which show only cyclical changes in prices or cyclical changes combined with a trend of price change. For such items, the cyclical variation in price parallels the variation in consumer buying power so that the separate influence of each of the two factors cannot be easily disentangled.

The relative stability of a great many nonagricultural and a few agricultural prices and the relatively minor effect of price changes in other commodities means that there is a large group of commodities for which price changes are a minor factor in accounting for changes in consumption. For an even larger group of goods, much of the variation in price is either of a cyclical or secular character so that the influence of price changes can be largely accounted for as a matter of time trend or as a function of consumer buying power.

On the other hand, buying power received as income by individuals appears to be the most important single factor in accounting for variation in consumption in recent years for most commodities and an important factor for practically every commodity. A simple case of this relation is found in the consumption of paints and varnishes. When the volume of paints and varnishes is plotted against consumer income as is done in chart VII, it is apparent that the bulk of the variation in consumption is paralleled by variation in new buying power.[3] In the case of the tobacco industry, consumption shows a time trend as well as the influence of consumer income. This is indicated in chart VIII, which shows consumption plotted against consumer income. As income declines, consumption declines, as indicated by the line AA′. In addition, however, consumption increased through time, the earlier years being below the line and the later years above it. This trend through time is represented by the line BB′. Here again, this continuing relationship can be expressed by a formula and the actual and calculated consumption can be compared as in the lower panel of chart VIII.

In some cases, price appears significant, not as an absolute figure, but in the relation between the price of a particular product and the price of a competing product. Thus, in the case of bituminous coal, variations in the price of coal do not appear to have caused significant changes in coal consumption, but variations in the ratio of coal to fuel oil prices appear to affect the consumption of coal significantly, and account can be taken of this added factor in the formula derived.

For other items, price itself, or the ratio of price to the level of all prices, appears to be significant. Thus, for the shoe industry, consumer income, time, and the ratio of the price of shoes to the level of all prices in combination, parallel most of the variation in shoe consumption.

In still other cases, the relationships showing con-

CHART VIII

TOBACCO CONSUMPTION

RELATED TO CONSUMER INCOME AND TIME

1919-1932

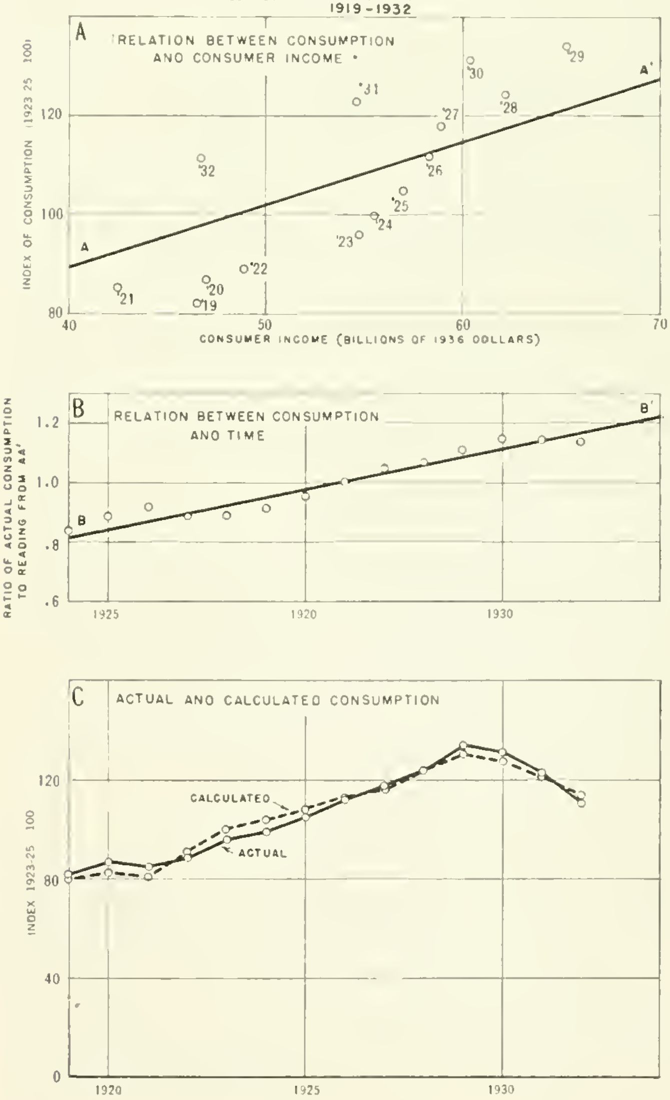
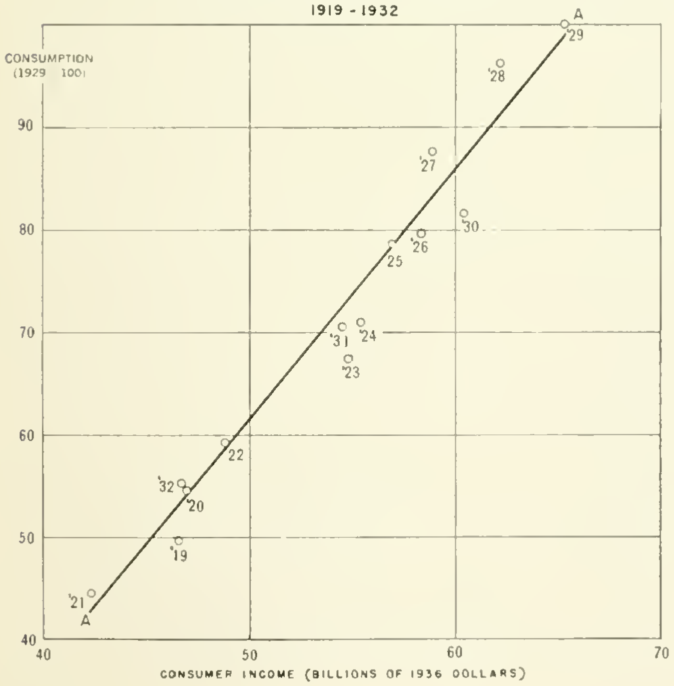


CHART VII

PAINT AND VARNISH INDUSTRY

RELATION BETWEEN CONSUMPTION AND CONSUMER INCOME

1919 - 1932



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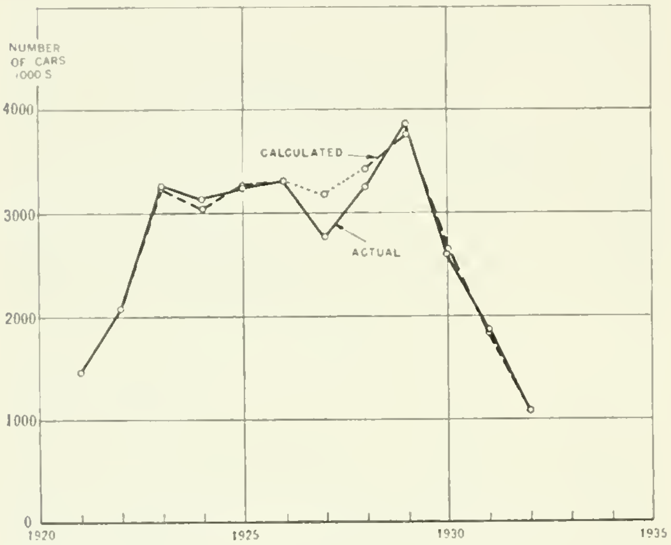
[3] It should be noted that this does not mean that variations in prices have not occurred or influenced consumption. It only means that such variation in price as occurred must have coincided almost exactly with variation in consumer income or that to the extent the variation in price failed to coincide with variation in consumer income, its influence was offset by other developments. For example, the influence of a steadily declining price which might be expected to bring increased consumption might be just offset by the development of a competing commodity which would have reduced the consumption of the first commodity if its price had not been reduced.

tinuity appear to be more complex. The purchase of automobiles is a clear example. In spite of the wide fluctuations in automobile sales and the fact that automobiles are consumers' durable goods whose purchase is easily postponable, a large proportion of the variation in the total number of automobiles sold can be paralleled by four factors: the buying power received by wage earners as income, the buying power of other recipients of income, a time trend, and the number of automobiles more than 7 years old that are in use. The number of old cars is a rough index of the replacement market, though new buying power appears to affect somewhat the length of time cars continue to be operated, while the improving quality of cars tends to increase the average life. The use of two indexes of income seems to be necessary, because in the lower income brackets, a given increase in income appears to increase the number of new cars purchased much more than would be purchased by the same increase in income in the higher income brackets. The actual figures for automobile sales and the figures calculated from a formula employing these four factors are plotted in chart IX. Considering the variability of automobile sales, a reasonably good fit has been obtained. Even here, a considerable amount of continuity in underlying relationships appears to exist.[4]

CHART IX

PASSENGER CAR SALES

ACTUAL AND CALCULATED RETAIL SALES



These examples, when combined with the many similar examples given in chapter VI, constitute clear evidence that a considerable degree of continuity can be found in the relationships underlying economic activity. They do not, however, give any evidence that the continuity of relationships shown in the past is likely to continue in the future. A sudden change may occur and cause a new type of relationship to develop. If underlying continuity is to be an aid in planning for the better use of resources both by industry and by Government, it must be shown that the underlying relationships which have shown continuity in the immediate past are likely to show continuity in the immediate future. The next chapter will consider this problem.

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[4] It should be recognized that this is a tentative formula. As more data become available and as analysis of the factors involved is extended, it should be possible to develop improved formulae. Two papers, which were presented at the December 1938 meetings of the Statistical Association in Detroit, have contributed to this process, by developing a formula which takes into account such factors as supernumerary income, price of automobiles, car population, and age of cars. Time will give a basis for selecting the more reliable formula from the many which could be developed. By having several such formulae, it is possible to select one likely to be more satisfactory than the others, depending on the particular purpose for which it is to be used.

III. PROJECTING THE RELATIONSHIPS OF THE PAST INTO THE FUTURE

The continuity in underlying relationships shown in the preceding chapter applies only to the past. If it is to have any significance as a guide to policy in the future, it is necessary to establish that the underlying relationships of the past are likely to continue at least into the immediate future. Even though it can be shown that automobile purchases have in the past borne a certain relation to consumer buying power, to the number of old automobiles in use, and to time, is there any reason to think that this relationship will continue to hold? Will the volume of paints and varnishes purchased continue to vary directly with consumer buying power? Will employment in the baking industry continue to bear the same relation to production as in the past, and will employment in the cotton textile industry continue to bear a steadily declining ratio to production?

While nothing absolutely certain can be said about the future, it is possible to make certain tests as to the likelihood that these underlying relationships will hold for at least a few years in the future. In each of the examples of continuity given in the preceding chapter, the formula representing the underlying relationships was worked out without using any data for years since 1932 and without even examining such data. Since comparable data are available after 1932, it is possible to calculate from these formulas what employment or consumption would have been in subsequent years if the underlying relationships of the earlier years had continued to hold. If the calculated figures agree closely with the actual figures, one can conclude that the underlying relationships of the first period have continued into the second.

Such a calculation has been made for each of the examples already given as evidence of continuity. Chart X shows the results, with the extrapolated estimates after 1932 indicated by the dotted lines. In each case the calculated value tracks right along with the actual value in the years after 1932 almost as well as in the years for which the relationships were actually worked out. The fact that, for example, the calculated figures for tobacco consumption from 1933 to 1936 continue to fall on top of the actual consumption, indicates that for this industry the relationships found to hold in the earlier years have continued to hold during the subsequent years. The similar tracking of the calculated and actual in the other cases reflects the basic continuity extending into the later years.

Some idea of the extent to which such relationships for one period of years continue to hold in the immediately following years can be obtained by examining the results obtained in a series of analyses of employment and consumption which are presented below. In making these analyses, all economic activity in the United States was divided into 81 segments—the shoe industry, the cotton textile industry, automobiles, railroad transportation, post office, education, and a host of other economic segments.[1] For each segment an analysis was undertaken of the relationships underlying employment and those underlying consumption to discover any underlying continuities. This involved 140 separate analyses, most segments requiring 1 employment and 1 consumption analysis, although in many service segments the output of the segment had to be measured in terms of manpower employed so that only a single analysis was called for. In a large proportion of these 140 analyses, it was possible to derive a fairly simple and reasonable formula to state relationships existing through 1932. In the remaining cases formulas were developed for the period ending in 1932 which fitted the data for those years moderately well. When the formulas were tested with data for subsequent years, a few failed to show significant continuity in the underlying relationships either because the formulas were faulty or because no continuity in underlying relationships existed. Two analyses, those for agricultural manpower and for construction output, were not carried through to the point where actual tests could be made. However, 82 out of the remaining 138 analyses revealed a high degree of continuity, the average difference between the calculated and the actual being less than 5 percent in the subsequent 4 years. The distribution of errors for this group of 138 analyses, including the cases where the subsequent years did not fit well, is given in chart XI. The number of cases in which the calculated averaged less than 5 percent of the actual is evidence of a considerable degree of continuity in the relationships.

A more technical measure of the relation between the actual data and the formulas derived is to be found in the statistician's "standard error of estimate." This measure has been developed by statisticians in connection with formulas for estimating the characteristics of a given universe or set of events from a sample set of observations presumed to be random and independent of each other. It is used not only to state the degree to which such a particular formula fits the data from which it is derived but also as an index of the reliability of the formula as indicated by the theory of probabilities. Since the time series analyzed in this report do not constitute random and unrelated samples, and since no one appears, as yet, to have developed a theory of probabilities applicable to a nonrandom and serially intercorrelated sample, there seems to be no justification for reading into the standard errors presented in this

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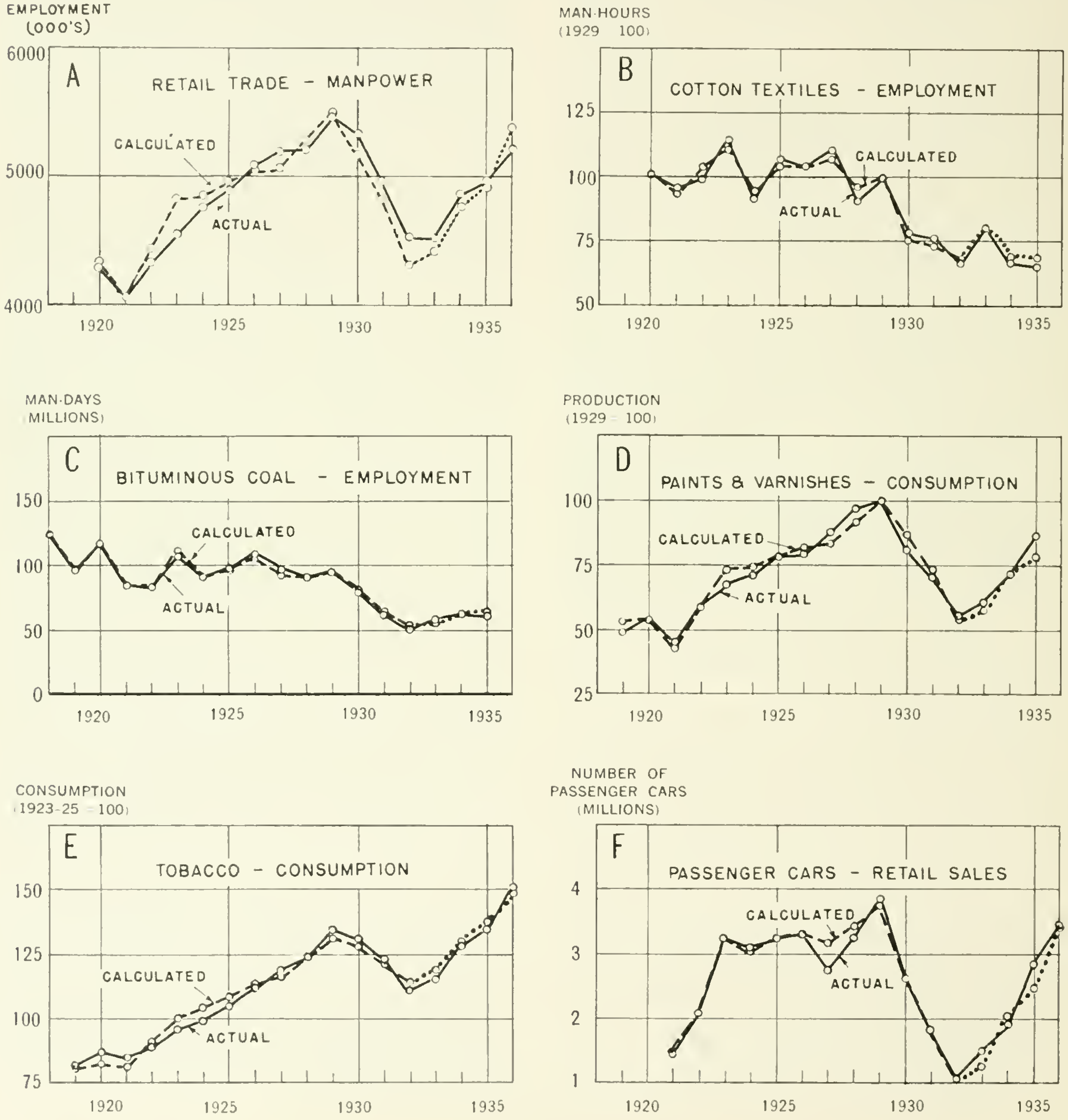
[1] The term "economic segment" or just "segment" is used here rather than the term "industry" partly because such activities as education, domestic service, and the like are not customarily referred to as "industries" and partly because the lines of division between industries made for purposes of the above analysis may not fit the customary industrial divisions.

CHART X

COMPARISON OF ACTUAL AND CALCULATED VALUES IN SELECTED SEGMENTS



report any implications as to probability. The standard errors are presented here only as a concise mathematical statement of certain of the relations between the actual data and the formulas developed. A low standard error would indicate a good fit between formula and data just as would a low average error. The standard error gives a more comprehensive statement of fit than average error since it takes into account more factors of significance. Neither measure of fit when applied to these time series has been assumed in this report to state the probability that the formula will fit the data for subsequent periods. Rather the inadequacy of probability theory as applied to time series leads to the procedure of saving out the data for the years after 1932 as a test for the formula developed.

In chart XII the average discrepancies between actual and calculated in the years after 1932 are plotted against the standard errors, both the discrepancy and the standard error being stated as a percent of the average value for the period ending in 1932. The line "Average error=standard error" divides the chart in such a way that in cases where the average error in the period after 1932 is greater than the standard error of the formula, the corresponding point on the chart lies above the line and if less, the point lies below the line. The higher the points lie in relation to this line, the more significant are the errors involved in the extrapolation as evidence of the unreliability of the formula and the further to the right, the less reliable the formula. The bunching of points to the left of the chart and below the line suggests the high proportion of the formulas which are reasonably reliable.

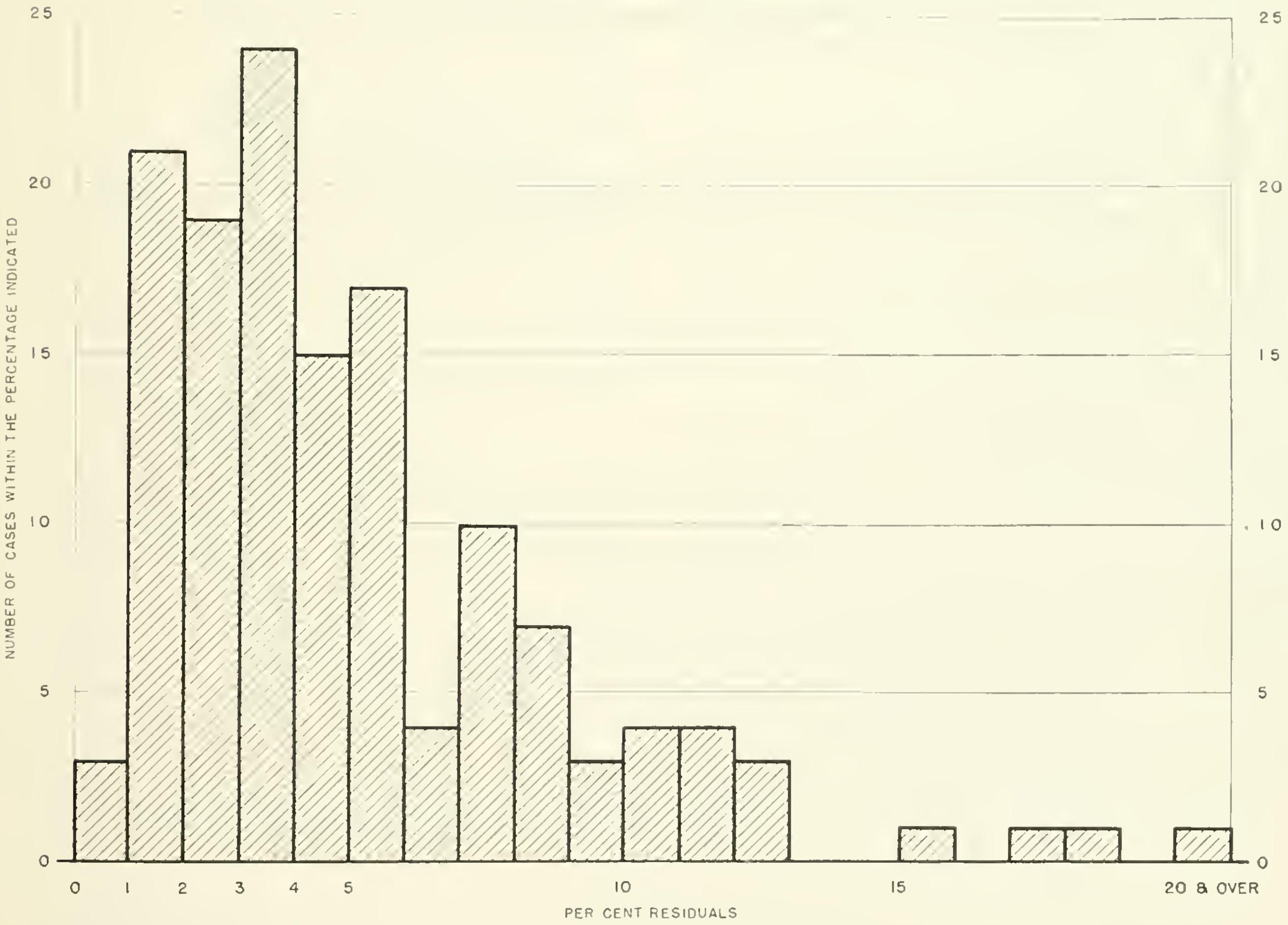
Further examination of the results of these analyses shows a considerable persistence of the underlying relationship even into the third and fourth year after the period for which the formulas were derived. In chart

CHART XI

DISTRIBUTION OF AVERAGE PER CENT RESIDUALS

1933-1936

(BASED ON 138 ANALYSES-RESULTS OF WHICH ARE GIVEN IN THE APPENDIX)



PER CENT RESIDUAL IS OBTAINED FROM THE RATIO OF ACTUAL LESS CALCULATED TO THE CALCULATED VALUE.

XIII, the differences between actual and calculated are plotted separately for each of the years after 1932 in the same manner as the average discrepancies. The location of the points in successive years indicates that most of the formulas are not seriously less reliable for the later than for the earlier years of extrapolation.[2]

In this material we have clear evidence that the underlying relationships which showed continuity in the period ending in 1932 continued to a considerable extent to hold in the immediately subsequent years. This suggests that continuing relationships worked out for the immediate past can be projected into the future with a fair likelihood that they will continue to hold.

All the relationships, however, which have shown continuity in the past are not equally likely to continue in the future. Once a particular set of relationships has been stated as a formula, it is possible to test the formula in several ways.

First, it is possible to compare the formula with the

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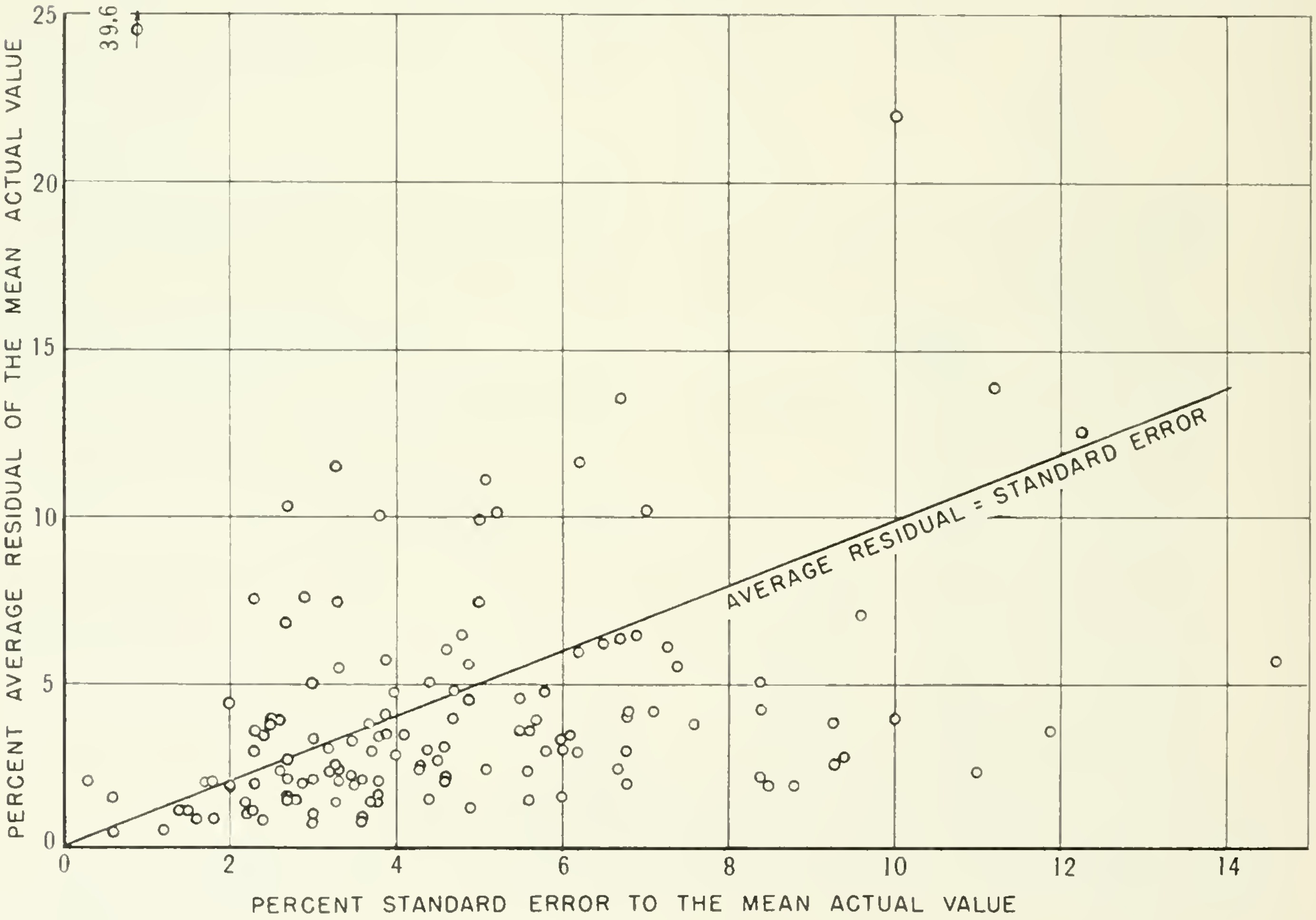
[2] A question has arisen in connection with this chart which calls for further investigation. If the theory of probabilities developed in connection with random sample analysis were applicable to time series, it would be expected that in the cases where the standard error was greater, the residuals actually found would be greater and that at each range of standard error, in approximately two-thirds of the cases the residual would be less than the standard error and in one-third of the cases would be greater. Examination of chart XIII indicates that the theoretical requirements are met for the group of cases in which the standard error was less than 4 percent of the mean actual value but are not met for the group of cases in which the standard error was more than 4 percent of the mean actual value. Does this failure to meet the theoretical requirements applicable to a random sample mean that this particular theory is not applicable to economic time series; that the theory is applicable to such series and that the failure of the results to meet expectations is an indication of some significant but not understood characteristic of the data being analyzed; or that even though the theory is applicable to time series in general, the conditions requisite to its application were not met in the particular case? (For example, in a large number of cases in which the standard error is high, the data after 1932 are appreciably more reliable than the data from which the formula is derived; also because of the high intercorrelation between successive years in the data, it is impossible to obtain a precise figure equivalent to the number of independent observations and therefore the remaining degrees of freedom cannot be precisely known.) This problem requires further investigation.

CHART XII

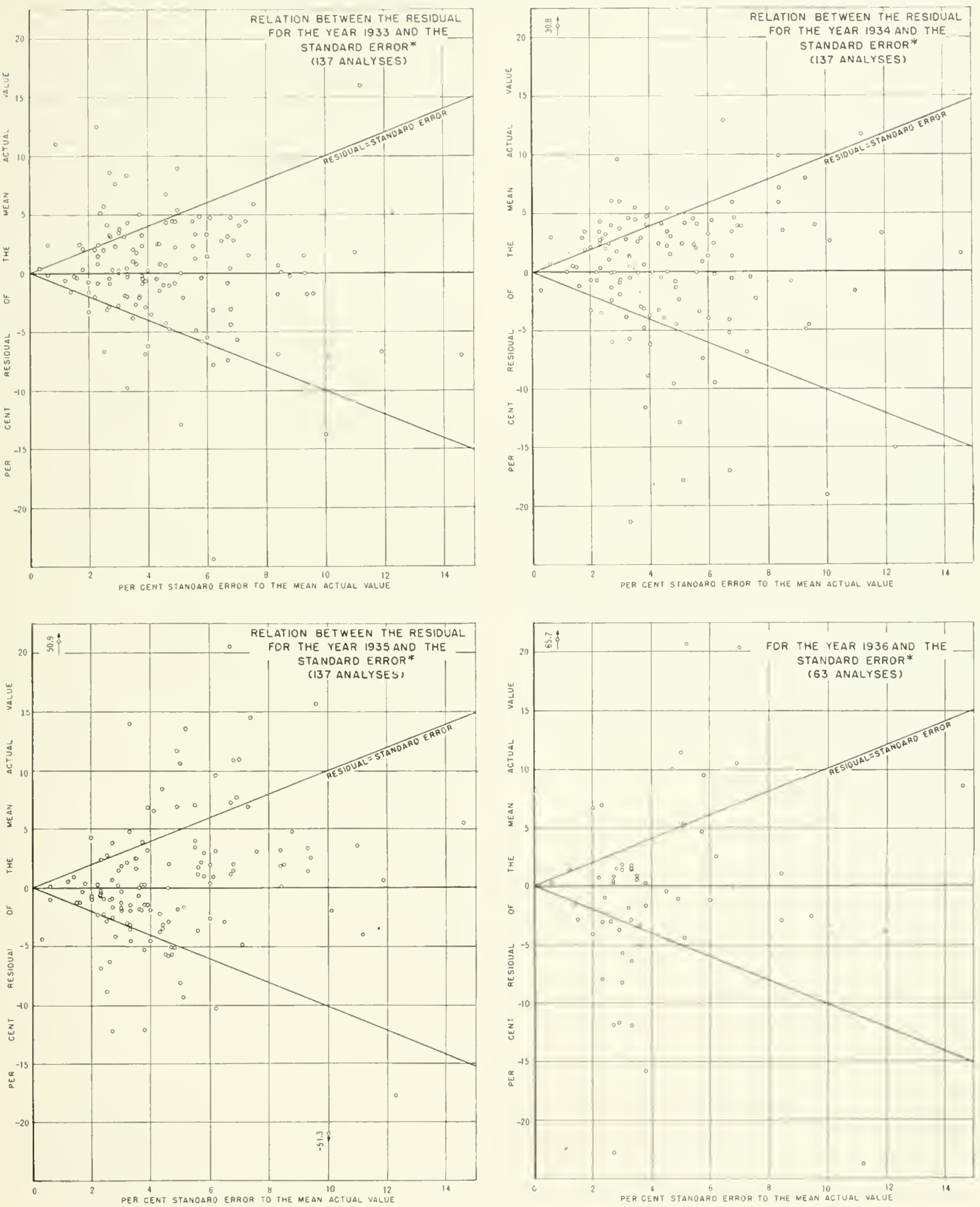
RELATION BETWEEN THE AVERAGE RESIDUALS FOR THE YEARS 1933-36 AND THE STANDARD ERROR OF ESTIMATE (138 ANALYSES)



STANDARD ERROR OF ESTIMATE IS DERIVED FROM THE FORMULA AND THE DATA FOR THE PERIOD ENDING WITH 1932

CHART XIII

RELATION BETWEEN THE RESIDUALS FOR THE YEARS 1933–1936 AND THE STANDARD ERROR OF ESTIMATE



*STANDARD ERROR OF ESTIMATE IS DERIVED FROM THE FORMULA AND THE DATA FOR THE PERIOD ENDING WITH 1932 actual data. Does the formula fit the data closely or only roughly? This comparison can be made visual by the method adopted in charts V to X. It is clear from the charts that the formula representing the relation between tobacco consumption and consumer income and time fits the observed data much more closely than the relation between cotton textile production, manpower, and time. This is also shown in the difference in the standard error, expressed as a ratio to the mean value, that for the first being 0.03 and that for the second being 0.04. If the fit between the actual and the calculated is poor, the particular combination of relationships can be discarded as not likely to continue to hold in the future. On the other hand, if the fit is close, the relationship deserves and requires further testing. The fact that the fit is good does not mean that the particular relation is likely to hold in the future. Too often, quite separate items vary together for short periods of time, yet they are not likely to continue to do so. Only as further tests are met can a formula representing the underlying relationships be regarded as reliable.

A second test is that of reasonableness.[3] Does the relationship found seem to be a reasonable one? It is only common sense that, for most industries, employment is greater when production is greater or that consumption of tobacco is greater when consumer income is greater. Each element in the relationship must be put to this test of reasonableness.

The third test is that employed above in extending the time period covered. By calculating what the consumption of tobacco would be in years subsequent to or prior to the period from which the relationships are derived and comparing the result with the actual figures, considerable light can be thrown on the reliability of the relationships. In the case of the present analyses, any extension backwards involved using data of the unsettled war or immediate post-war period, so that this test has not been used. Since the problem is to test whether the relationships can be extended into the future, the more significant test is to apply data for the years after those for which the relationships have been developed. If a formula continues to fit the facts well for 3 or 4 subsequent years, there appears to be considerable likelihood that, if no catastrophic changes such as war or revolution take place, it or a comparable formula based on the whole period will continue to fit for at least a few years more, though perhaps with declining accuracy in subsequent years as has been indicated above.

Finally, the most rigorous test is the future itself. If those relationships, which are worked out now and which are regarded as reasonably reliable, are published, the facts of subsequent years can be applied to test their reliability.[4] Gradually by such a testing process it should be possible to build up a knowledge of the continuities underlying economic activity. Such knowledge would constitute part of the essential backlog of knowledge necessary to the more effective use of national resources.

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[3] In discovering the relationships shown in this report, the test of reasonableness was in most cases applied before any statistical relationships were worked out. For example, in considering tobacco consumption, a hypothesis was first developed to the effect that most of the variation in tobacco consumption would be accounted for by (1) variation in consumers' income, and (2) variations of other sorts operating through time such that their net effect would be reflected by an increasing time trend. This hypothesis was then tested by analyzing the actual data. In this case the first hypothesis proved correct. Because the relationship was justified on rational grounds before it was established statistically instead of being rationalized after it had been discovered through trying out various possibilities, somewhat more reliance can be placed upon it.

[4] The sharp break in economic activity subsequent to the summer of 1937 and the lower level of activity in the period immediately thereafter should give an excellent basis for testing the various formulae.

IV. DISCONTINUITIES

While the material presented in the preceding chapters gives clear evidence of continuities underlying economic activity, it should not be taken as evidence that there are no significant discontinuities. Several cases of what appear to be significant discontinuities have developed in the analyses made so far. Possibly the determination of major discontinuities is as significant for national policy as the determination of continuities.

When the analysis discloses no clear evidence of continuity, it provides prima facie evidence of discontinuity. This may reflect true discontinuity in the operations of the industry being analyzed or it may reflect only a failure on the part of the analysts to discover the significant relationships underlying the operations and can be regarded as pseudo discontinuity. In both cases, there is discontinuity insofar as the drafting of patterns of resource use is concerned, although, in the second case, the appearance of discontinuity can presumably be eliminated by more adequate data and analysis.

The most clear-cut cases of true discontinuity have been disclosed in the analysis of Federal Government employment and employment in the banking and finance segment. In the case of Federal employment, a formula was developed which fitted the data for 1932 and prior years fairly closely and seemed to be reasonable. When this formula was applied to the years following 1932, however, it failed to fit the facts by a very wide margin. This failure is indicated in the first panel of chart XIV. The formula did not reflect the factors which brought about the tremendous increase in Federal employment subsequent to 1932. While this increase of Federal employment might have been foreseen on general grounds as a result of a deep depression and a shift of party in power, the statistical information relied upon in making the analysis of the relationships underlying Government employment did not suggest such a development. A sharp break in the economic relationship underlying Federal employment seems to have occurred—a discontinuity reflecting a change in national policy.

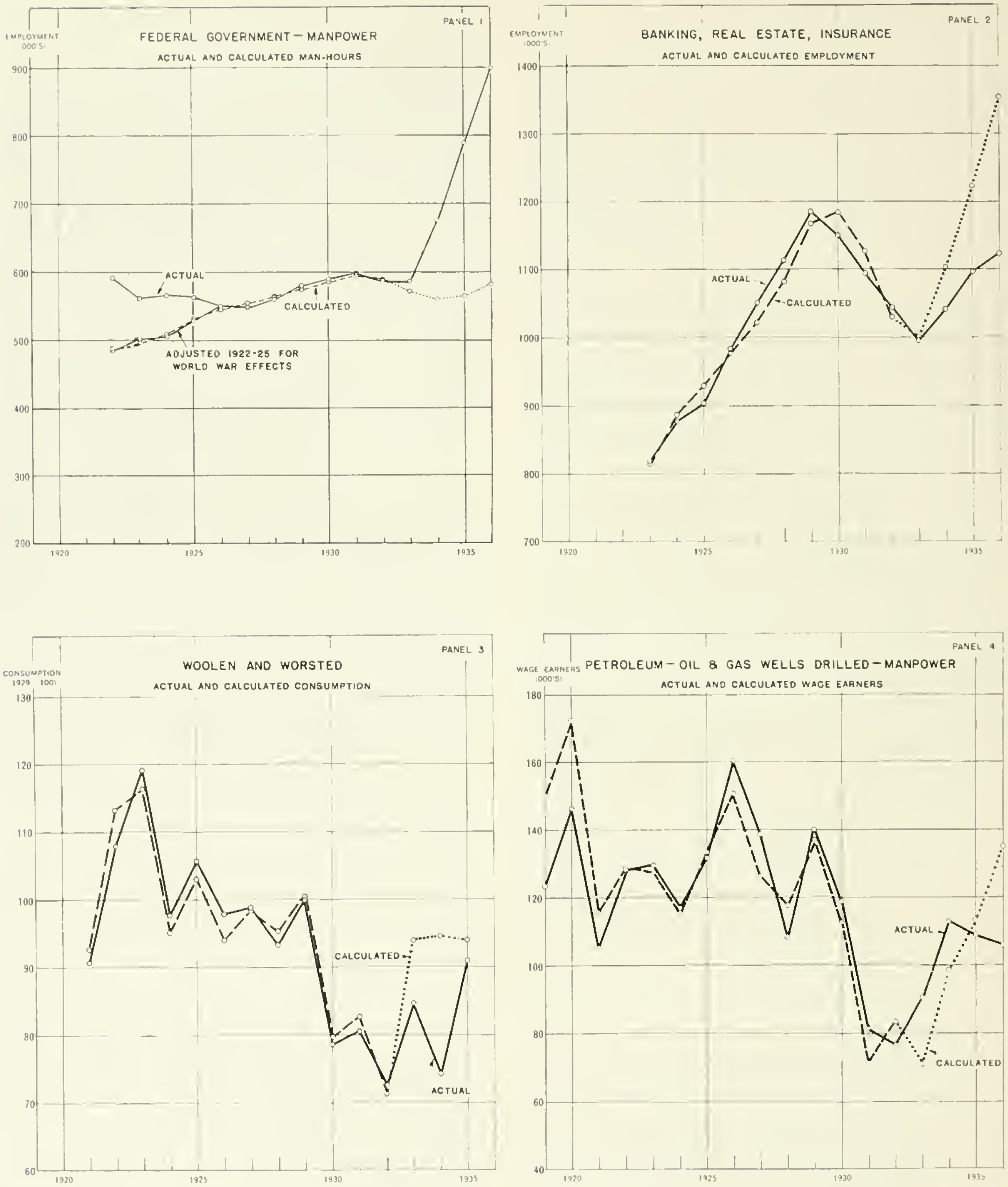
The second clear case of discontinuity appears in the field of banking and finance. Here, as in the case of Federal employment, a fairly satisfactory formula was developed for the period ending in 1932 but the formula clearly did not fit the subsequent years as is shown in panel 2 of chart XIV. Here again, examination of the statistical material made it evident that the lack of fit was not due to a faulty analysis. The volume of employment after 1932 was way below what could reasonably have been expected in the light of the experience of the immediately preceding years. It is evident that the drastic reorganization of the banking system following the bank closing of March 1933 resulted in a marked curtailment of employment which, combined with a significant shift in financial functioning from private to Government hands, represented a sharp break with the relationship between private banking employment and economic activity which had previously existed.

It is an outstanding characteristic of these discontinuities that they involved significant political and administrative decisions and that at the time they occurred there was ample nonstatistical evidence to give warning of the likelihood of a change in the underlying relationships. A shift in Federal administration should be fair warning that a formula for Federal employment derived from the past must be scrutinized carefully and tested against the actual employment to be sure that new underlying relationships have not been developed by the political change. So also, the bank reorganization would itself be a signal of a possible change in underlying relationships. Such signals would indicate that in such cases the particular formulas reflecting past relationships can be projected into the future only with the greatest caution and possibly may have to be rejected altogether.

In other cases, a temporary discontinuity is sometimes found again involving political or administrative decisions of major import. Thus, in automobile sales, the relationship found to hold fairly consistently between automobile sales, income, old cars, and time does not hold in 1927. That was the year in which the Ford plants were closed down as a result of the administrative decision to replace the old model T with a new model. Likewise in 2 strike years, the relationship between anthracite coal consumption, consumer income, and time was clearly different from the relationship existing in other years. In such cases, an unusual factor enters in to distort the usual relationship. However, an unusual factor sufficiently important to affect significantly the relationships that usually exist would in most cases be sufficiently evident to give clear warning of the likelihood of discontinuity. Such cases of temporary discontinuity do not appear to be sufficiently frequent to invalidate the type of analysis being employed in this report but they do require particular watchfulness both

CHART XIV

EXAMPLES OF ANALYSES SHOWING DISCONTINUITY



FOR THE FACTUAL DATA AND METHOD USED SEE APPENDIX in developing formulas to represent underlying relationships and even more important, in the projecting of such relationships into the future.

Cases of what appears to be pseudo discontinuity are shown in the third and fourth panels of chart XIV. The formula developed for woolen and worsted consumption fits the data for the period ending in 1932 fairly well, though less well than the bulk of successful analyses. However, the consumption in subsequent years is very much less than the formula would suggest. In this case, lack of adequate statistics on the industry made it necessary to use data which were known to be unreliable. The index of "consumption" actually employed in the analysis is admittedly faulty. It is essentially an index of production. To be a satisfactory index of consumption it should be adjusted for changes in "stocks on hand." Yet no adequate index of stocks or changes in stocks is available to correct the cruder index. Under the circumstances, clear evidence of continuity would be expected only if stocks on hand varied in close relation to production—an unlikely condition in this industry. Because of this, the analysis cannot be expected to give reliable results. It seems likely that the discrepancy between the calculated and the actual figures after 1932 is due to the inadequacy of the data and the incompleteness of the analysis. Until better data allow a more reliable analysis to be made, it would be incorrect to regard the apparent discontinuity as significant.

Employment in petroleum production shows the same lack of good fit and likewise involves inadequacies in the available data. Has control of petroleum production during the recovery period altered the underlying relationship in production or are the data too inadequate for effective analysis? Further analysis may furnish the answer.

In other analyses which yielded similar poor results and suggested the possibility of discontinuity, the data used were so unsatisfactory that no conclusion as to significant discontinuity could be reached. In other cases, the apparent discontinuity is felt to be a result of inadequate analysis. Only in a relatively few cases has convincing evidence of discontinuity been discovered. On the whole, the 140 analyses give an impression dominated by the presence of essential continuity, while significant discontinuity appears as the exception rather than the rule.

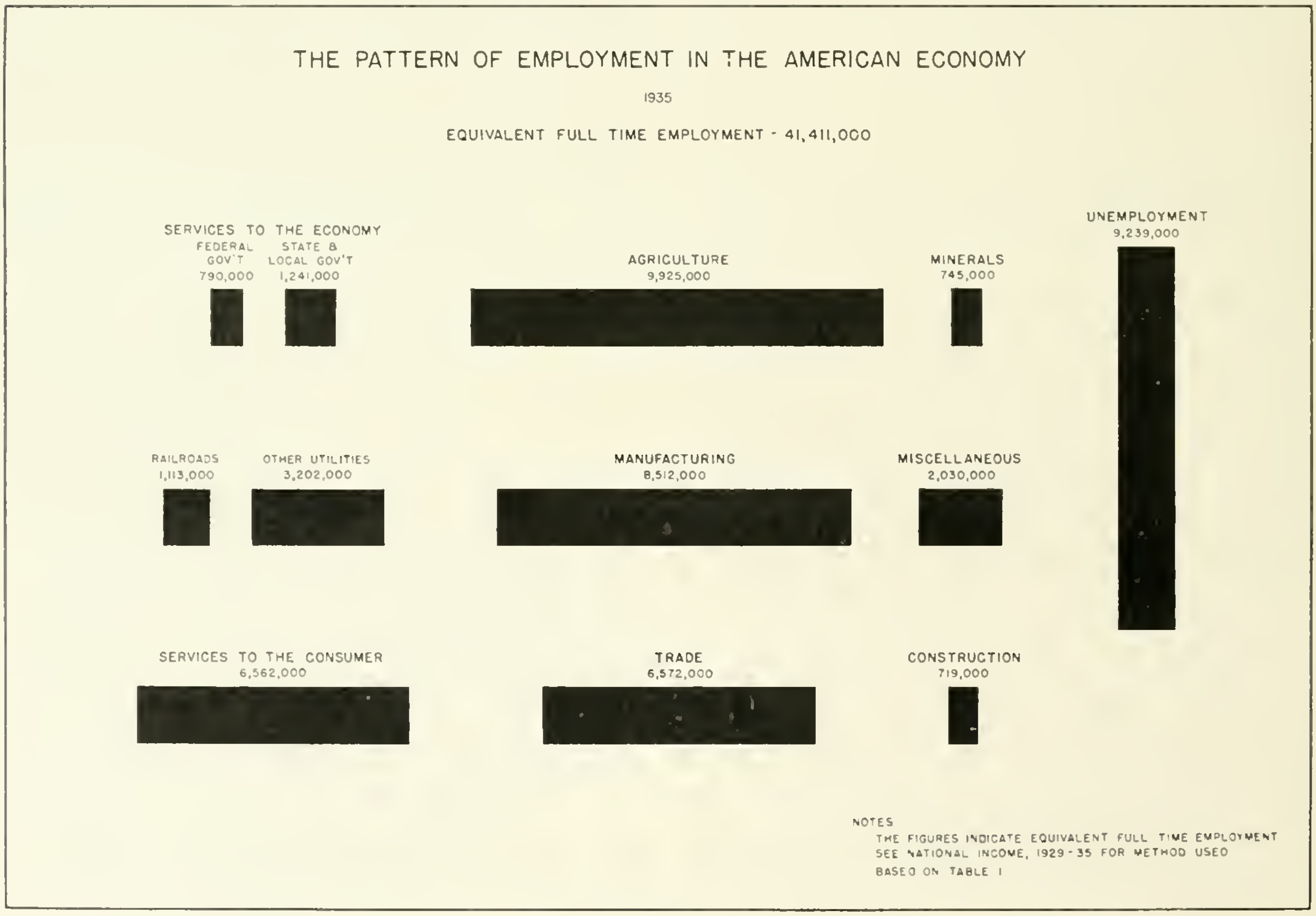
V. PATTERNS OF RESOURCE USE

The preceding chapters have shown that it is possible to discover continuing relationships underlying the complex ebb and flow of economic action. They have also shown that, on a basis of testing, it is possible to select those relationships which seem likely to hold in the immediate future provided no violent changes in conditions occur such as would be brought by war or revolution. It is the purpose of this chapter to indicate that it is possible on the basis of such continuing relationships to show how resources are likely to be used in the future under various possible conditions. The next chapter will present some actual though not too reliable patterns of resource use for 1938. The possibility of developing more reliable patterns and the value of such patterns as an aid in the making of national policy will be discussed in subsequent chapters.

Just what would a pattern of resource use be like? A pattern of resource use would be a statement of the resources used in any given period and the goods and services resulting from this use. A resource-use pattern for any particular year would show the manpower, natural resources, and equipment used and the things produced. It would be an input-output pattern—a pattern showing the conversion of resources into useful goods and services. It might be given in more or less detail but it would have to cover the whole of the national economy and show the essential pattern of activity, however meager the detail.

One of the major elements in such a pattern of resource use is manpower, the most important item of input. Insofar as measurement makes possible, the pattern of employment in 1935 has been worked out, dividing the economy into 11 different functional segments, such as agriculture, manufacture, and trade. Chart XV shows the manpower employed in each segment, stated in terms of the number of full-time work-

CHART XV



NOTES
THE FIGURES INDICATE EQUIVALENT FULL TIME EMPLOYMENT
SEE NATIONAL INCOME, 1929-35 FOR METHOD USED
BASED ON TABLE I

ers, part-time work being converted to the equivalent full-time work. This equivalent full-time employment is represented by the size of the black areas. The left-hand part of the chart covers the service industries while the remainder of the chart shows the raw materials followed by manufacture and distribution or construction. Starting at the upper left-hand corner are the activities servicing the economy as a whole. The first block represents employment in the Federal Government exclusive of that supplying mail service which is grouped in the public utilities along with other forms of communication.[1] The block beside it represents employment in state and local governments exclusive of that engaged directly in education. This latter is classed with services to the consumer.[2] The third block represents employment in railroads and beside it that in utilities, primarily electric power, telephone, telegraph, and post office. For purposes of simplification, banking, and finance have been grouped with the utilities. The fifth block is made up of those activities primarily serving the ultimate consumer and involving little purchase of raw material. In such activities, manpower, including skills, is almost the only significant resource used and the bulk of the product is rendered directly to the ultimate consumer. This segment includes such activities as education, both public and private, professional service, domestic service, and amusements.

At the top of the chart in the center and on the right are the extractive segments, agriculture and minerals. The third source of raw materials, imports, is not shown as it involves no direct employment within the country. Below the raw material resources, the employment in manufactures is indicated and below this in turn are wholesale and retail trade and construction. At the right of the chart is a block representing a crude estimate of the manpower which was available in 1935 but was unemployed. This chart gives a clear indication of the pattern of resource use in 1935 insofar as manpower is concerned.

In order to complete the pattern of resource use, it would be necessary to provide data showing in addition both the natural resources and the capital equipment actually used in production and the output of economic activity. Data are not available in a form to complete the pattern of resource use for 1935. Enough has been given, however, to indicate what a completed pattern of resource use would be like.

Patterns of resource use could be delineated in more detail by breaking the economy into a larger number of segments. This also has been done for manpower input for the year 1935, dividing the economy into the 81 segments already mentioned. The resulting pattern of employment is shown in chart XVI following essentially the same layout as in the preceding chart.

These two patterns of resource use, already given, are statements, more or less detailed, of what happened in the past. Is it possible to construct similar patterns of resource use which apply to the future? Do the continuing relationships underlying economic activity give a basis for constructing such patterns?

In the examples of continuity in consumption relationships, consumer income and time played major roles in accounting for the variation in consumption. This means that for some subsequent year it would be possible to calculate consumption for a series of different commodities or services for any given volume of consumer buying power. If the real buying power received as income by consumers were to be 80 billion dollars, the formula for tobacco consumption indicates that the consumption of tobacco would be likely to be in the vicinity of 930 million pounds when the trend values for 1938 are introduced. If, on the other hand, the real buying power paid out to consumers were to be 60 billion dollars, only 822 million pounds of tobacco would be purchased. Likewise, if the consumer income were 100 billion dollars, the corresponding tobacco figures would be 1,027 million pounds. Thus, although what the national income is going to be in any future year is not known, it is neverthless possible to approximate the relation that is likely to exist between national income and the consumption of tobacco in any year of the immediate future.

This same procedure can be applied to a whole series of segments so that many elements in the pattern of consumption at each level of buying power can be filled in. For some segments, certain assumptions as to price would have to be made but the number of such cases can be kept at a minimum. For still other segments, further assumptions would have to be made. Thus, in the case of automobiles, in order to use the formula given above so as to calculate the most likely volume of automobile sales in any year at each level of buying power, it would be necessary to estimate the number of automobiles 7 years old or older which would be in use at the end of the preceding year. This can be done with sufficient accuracy for the purpose of calculating purchases in the next year or two. It would also be necessary in this case to specify the proportion of the buying power received by consumers as wages and that received from other sources.

On the basis of this type of procedure, it would be possible to work out the major elements in the pattern of consumption which is likely to develop in a particular year under each different set of conditions as to buying power, price ratios, and other factors. A different consumption pattern could be developed for each set of conditions assumed. The different patterns would have this in common, that each would represent the pattern of consumption likely to develop in the year chosen if the underlying relationships showing continuity in the recent past should continue to hold. They would differ in that each pattern would relate to a different set of conditions, any one of which might develop. Such patterns would not be forecasts of the consumption that will occur, since no forecast is made as to which set of conditions is most likely to arise in that year. The pattern would only indicate that if one set of conditions developed, there would be a certain pattern of consumption, if another set of conditions, a second pattern would represent the consumption likely to occur.

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[1] There are other activities of government which should be included with the public utilities such as T. V. A., municipal power plants, etc., but figures for employment in these activities are not available and the essential picture would be little altered by making this small adjustment.

[2] Undoubtedly other activities of Government should be classed as services to the consumer but these could not be readily disentangled from services to the economy as a whole except in the important case of education.

Just as it is possible to develop a pattern of consumption related to each set of assumed conditions, so it is also possible to develop patterns of employment which would be related to the pattern of consumption. If, for a given set of conditions, the pattern of consumption included the consumption of 400 million pairs of shoes, it would be possible to calculate the manpower which is likely to be used in making shoes, in making leather, and so on, back through the process of production. In this way, the different elements in the pattern of employment corresponding to a particular consumption pattern could be worked out until the full pattern of employment for the economy is blocked in.

Again, as in the case of the consumption patterns, some additional assumptions would have to be made as to the conditions affecting employment. Thus, a change in hours worked per week would usually change the number of workers required for a given output and in many cases, specific assumptions as to working hours would have to be made. Since experience has shown that most of the variation in employment reflects changes in volume of output, hours worked, and time trend, the number of instances where other elements in the conditions of employment have to be specifically introduced are relatively few so long as the subdivision of segments is not carried too far.

In gaging the employment involved in a given amount of consumption, account should be taken of changes in inventory. A consumption of a hundred million shoes may not involve a production of an exactly equal number of shoes in the same time period. Inventory can be used up so that consumption is greater than production, or production can be the greater with a corresponding increase of inventory. For many industries such as those supplying services either to the economy or to the ultimate consumer, there is no problem of inventory. For other industries, the variations in inventory are so small in relation to variations in total production that they become a wholly secondary factor and can be disregarded. For still others, inventory changes must be taken directly into account, a problem which is discussed in the Appendix.

A consumption pattern and a corresponding employment pattern together constitute the two most important elements in a pattern of resource use. All of the output is thereby covered and the most important single item of input. Experimental work has been carried on in an effort to construct such patterns using trend values for 1938 and the results, rough though they are, clearly indicate the feasibility of developing consumption and employment patterns. No effort has yet been made to construct patterns of capital equipment or of natural resources used which would correspond with the consumption and employment patterns so as to complete the patterns of resource use. However, the evidence points to the possibility of constructing such patterns if the data on the use of equipment and resources were available for all the segments of industry instead of for only a few. In the absence of adequate data on natural resources and equipment used, the patterns presented in the following chapter include only labor on the input side to correspond with the output pattern at different levels of consumer income.

The procedure adopted in developing these patterns consists in the main of tracing through the implications for the rest of the economy of a given volume of consumer income or new consumer buying power. This does not mean that a given volume of consumer income will produce a certain level of economic activity, but only that it corresponds with such a level. It may be that a given level of activity produces a certain level of consumer income or both may reflect a third set of factors. No causation is assumed in building the respective patterns around given levels of consumer income. Rather this was found to be a convenient procedure. Another method would have been to build patterns not around consumer income—the money income paid out to consumers—but around real national income—the income produced in a period and made up of the food, clothing, and shelter the new factories and machinery actually produced.[3] The patterns of resource use oriented to consumer income have the advantage of breaking into the economic process at a point that is easily grasped. Other patterns oriented to real national income produced should be equally valuable and should indicate essentially the same relationships.

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[3] By this second method the physical production which constituted real national income would be broken down into its constituents and the corresponding employment calculated. The resulting patterns would have the same character as those based on consumer income. When both methods take full account of changes in inventory and capital equipment, they should give identical results.

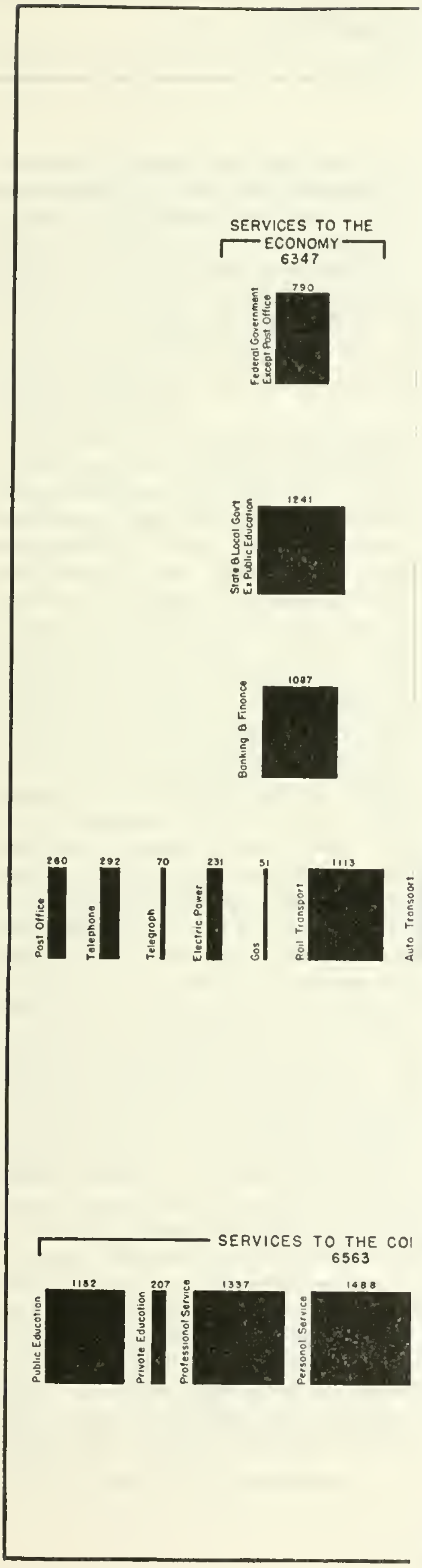
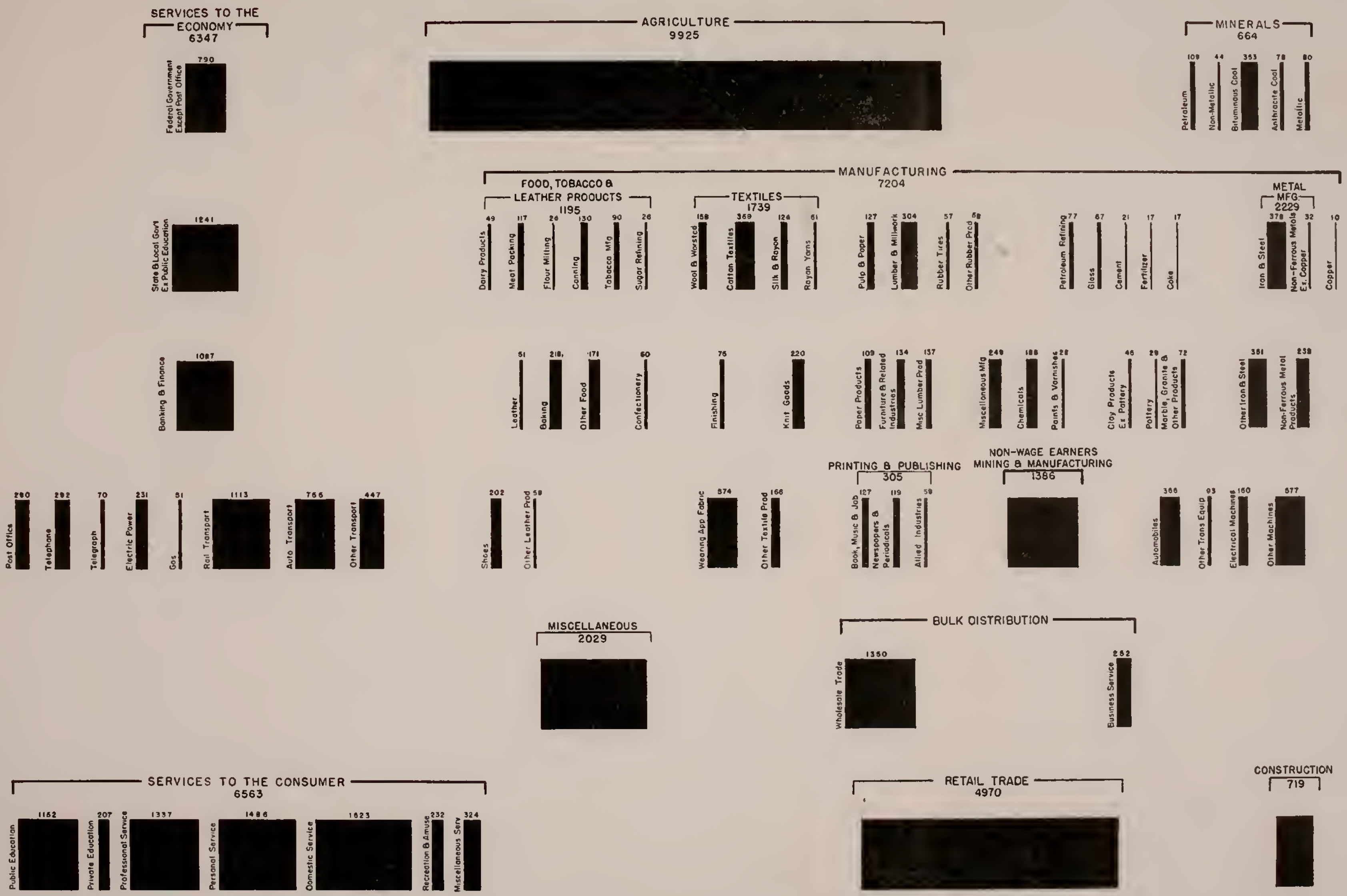

SERVICES TO THE ECONOMY
6347
790
Federal Government Except Post Office
1241
State & Local Govt Ex Public Education
1087
Banking & Finance
260
Post Office
292
Telephone
70
Telegraph
231
Electric Power
51
Gas
1113
Rail Transport
Auto Transport
SERVICES TO THE CO
6563
1182
Public Education
207
Private Education
1337
Professional Service
1488
Personal Service

CHART XVI

THE AMERICAN ECONOMY

1935

EQUIVALENT FULL TIME EMPLOYMENT – 41,411,000



FIGURES FOR EACH SEGMENT GIVE MAN-YEARS OF WORK IN THOUSANDS

NOTES:
THE FIGURES INDICATE EQUIVALENT FULL TIME EMPLOYMENT (SEE NATIONAL INCOME, 1929-35, FOR METHOD USED

FOR SOURCES, SEE APPENDIX

VI. APPROXIMATE FUTURE PATTERNS

Patterns of resource use applicable to the future have been worked out in two quite different degrees of detail. For one set of patterns the whole American economy has been divided into only 11 segments, while for the second set it has been further subdivided, giving 81 segments in all. The two sets of patterns should act somewhat as a cross check on one another. The second set with its greater detail should give a more reliable summation than the first, even though in detail it is at many points less reliable.

As a basis for constructing the first set of patterns, an effort was made to discover continuity in each of the 11 segments shown in chart XV. For the segments representing State and local governments, minerals, manufacturing, trade, railroad, other utility, consumer service, and miscellaneous, analysis disclosed very clear continuity in underlying relationships. For the large agricultural segment, no very clear continuity of relationships was discovered, but as both agricultural employment (including self-employed) and consumption of farm products have been relatively stable except for Government crop control, the failure to discover a high degree of continuity in underlying relationships is less significant for the purpose in hand than would be the case in a segment showing greater variability. For the construction segment, only rough continuities were discovered, making the projecting of past relationship into the future a less dependable procedure than in the other segments. The activity of the Federal Government shows a clear case of discontinuity, being to a greater degree a matter of variable national policy.

For each of these segments, a formula was developed from data for 1932 and prior years which stated the underlying relationship discovered.[1] The actual data for employment in nine segments are plotted in chart XVII, along with the corresponding figures calculated from each formula. Agriculture and miscellaneous are omitted because of the fact that the first shows little variation from year to year while the second is a catch-all of mixed elements for which only crude data could be found. The closeness of fit of the calculated to the actual in most cases presented is clear, while the agreement between actual and calculated in the years subsequent to the period on which the formulas are based is evidence pointing toward the reliability of the formulas. The poor fit obtained for Federal Government indicates the unreliability of that particular formula. For the three segments, Federal Government, agriculture, and construction, new formulas were developed using data after 1932. These new formulas are believed to be somewhat more reliable than those first derived; but since they have not been properly tested by time, they cannot be regarded as overly reliable. They are used for want of better formulas in constructing the resource-use patterns given below in the belief that they will not introduce serious error in the total picture. The methods for developing them are given in the Appendix.

These formulas covering each segment of the economy have been used to construct the patterns of resource use on the basis of 1938 trend values. The resulting patterns are given in table I, which shows, for a series of different levels of consumer buying power, the manpower which would be likely to be required in each segment. These patterns will later be compared with the patterns based on the analysis of 81 segments which follow.

When the American economy is broken down into the 81 segments indicated in chart XVI and each segment analyzed, a large proportion of the analyses disclose a significant degree of continuity. The continuity or lack of continuity underlying these segments is indicated in charts XXI to LVI, beginning on page 39, which show the actual figures of consumption and employment in each segment and the corresponding figures calculated from the formula developed. The charts also show the difference between the actual and calculated stated as a percent of the calculated. With the exception of a few cases, the formula has been worked out using data only through 1932 and the extrapolation into the subsequent years constitutes one of the tests for its reliability.

The formulas resulting from these analyses have been classified into four groups according to their reliability. Group A includes only those formulas which are regarded as reasonably reliable. A formula was classed in group A only if the differences between the actual and calculated values were small.[2] Thirty-two percent of the analyses fall in group A.

Group B consists of those analyses in which the data used were regarded as reasonably reliable but in which the formulas obtained did not fit the subsequent years so well, yet could be made to fit by a small alteration in the formula, such as a change in the slope of the time trend or a change from an addative to multi-

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[1] Given in the Appendix and in footnotes to table I.

[2] In technical terms a formula was classed in group A only if the coefficient of variation was less than 4 percent and if no error (expressed as a percent of the mean) in extrapolation in any year was greater than 1.5 times the coefficient of variation.

VI. APPROXIMATE FUTURE PATTERNS

Patterns of resource use applicable to the future have been worked out in two quite different degrees of detail. For one set of patterns the whole American economy has been divided into only 11 segments, while for the second set it has been further subdivided, giving 81 segments in all. The two sets of patterns should act somewhat as a cross check on one another. The second set with its greater detail should give a more reliable summation than the first, even though in detail it is at many points less reliable.

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For each of these segments, a formula was developed from data for 1932 and prior years which stated the underlying relationship discovered.[1] The actual data for employment in nine segments are plotted in chart XVII, along with the corresponding figures calculated from each formula. Agriculture and miscellaneous are omitted because of the fact that the first shows little variation from year to year while the second is a catch-all of mixed elements for which only crude data could be found. The closeness of fit of the calculated to the actual in most cases presented is clear, while the agreement between actual and calculated in the years subsequent to the period on which the formulas are based is evidence pointing toward the reliability of the formulas. The poor fit obtained for Federal Government indicates the unreliability of that particular formula. For the three segments, Federal Government, agriculture, and construction, new formulas were developed using data after 1932. These new formulas are believed to be somewhat more reliable than those first derived; but since they have not been properly tested by time, they cannot be regarded as overly reliable. They are used for want of better formulas in constructing the resource-use patterns given below in the belief that they will not introduce serious error in the total picture. The methods for developing them are given in the Appendix.

These formulas covering each segment of the economy have been used to construct the patterns of resource use on the basis of 1938 trend values. The resulting patterns are given in table I, which shows, for a series of different levels of consumer buying power, the manpower which would be likely to be required in each segment. These patterns will later be compared with the patterns based on the analysis of 81 segments which follow.

When the American economy is broken down into the 81 segments indicated in chart XVI and each segment analyzed, a large proportion of the analyses disclose a significant degree of continuity. The continuity or lack of continuity underlying these segments is indicated in charts XXI to LVI, beginning on page 39, which show the actual figures of consumption and employment in each segment and the corresponding figures calculated from the formula developed. The charts also show the difference between the actual and calculated stated as a percent of the calculated. With the exception of a few cases, the formula has been worked out using data only through 1932 and the extrapolation into the subsequent years constitutes one of the tests for its reliability.

The formulas resulting from these analyses have been classified into four groups according to their reliability. Group A includes only those formulas which are regarded as reasonably reliable. A formula was classed in group A only if the differences between the actual and calculated values were small.[2] Thirty-two percent of the analyses fall in group A.

Group B consists of those analyses in which the data used were regarded as reasonably reliable but in which the formulas obtained did not fit the subsequent years so well, yet could be made to fit by a small alteration in the formula, such as a change in the slope of the time trend or a change from an addative to multi-

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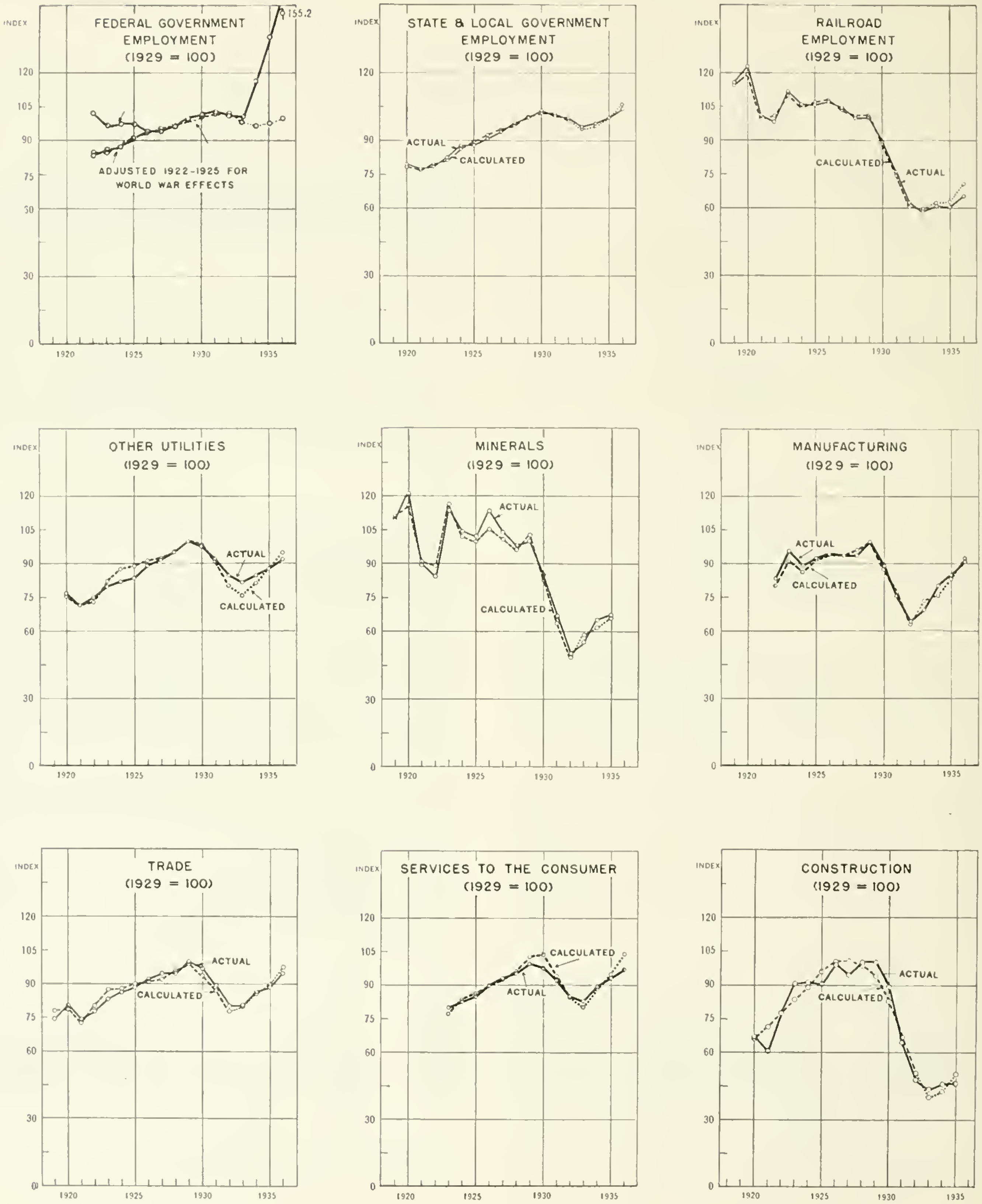
[1] Given in the Appendix and in footnotes to table I.

[2] In technical terms a formula was classed in group A only if the coefficient of variation was less than 4 percent and if no error (expressed as a percent of the mean) in extrapolation in any year was greater than 1.5 times the coefficient of variation.

CHART XVII

ACTUAL AND CALCULATED MANPOWER FOR NINE SPECIFIED SEGMENTS

1919 – 1932, EXTRAPOLATED BEYOND 1932



plicative form.[3] Here the formula which is actually used for calculating the figures in the patterns of resource use is not based solely on the material ending in 1932, but relies to some extent on the data for subsequent years. For this reason the resulting formula cannot be regarded as sufficiently tested to justify its inclusion in group A. Approximately 4 percent of the analyses fall into this group.

Group C included the 47 percent of the cases in which the underlying data were regarded as reasonably reliable and in which clear indications of underlying continuity were obtained but in which the formula either did not fit the data from which it was derived or the data in the years of extrapolation sufficiently closely to meet the rather rigid requirements set up for groups A and B. These segments require intensive work in the future. The analyses for group C are included in this report because they are relatively reliable.

Group D includes the 10 percent of the cases in which the underlying data were regarded as reasonably reliable and fairly clear evidences of discontinuity were found.

Group E includes the 7 percent of the cases in which the data were regarded as so unreliable that the resulting formulas are not themselves particularly reliable regardless of their fit. It is a striking comment on the continuities underlying economic activity that, with very few exceptions, where the data were reliable, the clear indications of continuity were discovered; whereas in the cases where the data themselves were classified as unreliable prior to the effort to discover continuity, less evidences of underlying continuity were apparent. In calculating the pattern of resource

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[3] To be included in group B, the revised formula must fit the data through 1932 with as low a coefficient of variation as is required in the case of group A and the errors of extrapolation must likewise be as low as those for group A. The only difference between group A and group B results from the minor alteration of the formula in the light of the data subsequent to 1932.

TABLE I.—*Patterns of resource use for the American economy—employment for 11 segments*

	Actual values for—		Assumed values					
	1929	1935						
Consumer income [1] (billions of 1936 dollars)	65.3	56.9	50	60	70	80	90	100
Industrial production [2] (1923–25=100)	119	90	68	90	113	139	166	195
	Actual patterns of resource use for—		Calculated patterns of resource use, assuming 1938 trend values					
	1929	1935						
	(Figures in thousands of equivalent full-time workers)							
Federal Government [3]	580	790	940	940	940	940	940	940
State and local government [4]	1, 237	1, 241	1, 381	1, 415	1, 448	1, 481	1, 515	1, 548
Railroad transportation [5]	1, 846	1, 113	892	1, 059	1, 236	1, 420	1, 607	1, 808
Other utilities [6]	3, 657	3, 202	3, 380	3, 646	3, 913	4, 180	4, 346	4, 713
Services to the consumer [7]	7, 021	6, 562	7, 310	7, 870	8, 430	8, 990	9, 550	10, 110
Agriculture [8]	9, 888	9, 925	10, 100	10, 100	10, 100	10, 100	10, 100	10, 100
Minerals [9]	1, 067	745	640	760	900	1, 030	1, 160	1, 300
Manufacturing [10]	9, 999	8, 512	6, 750	8, 470	9, 800	10, 970	11, 960	12, 750
Trade [11]	7, 399	6, 572	6, 060	6, 910	7, 770	8, 630	9, 490	11, 340
Construction [12]	1, 543	719	1, 052	1, 271	1, 452	1, 605	1, 742	1, 862
Miscellaneous industries [13]	2, 390	2, 030	2, 012	2, 249	2, 357	2, 538	2, 776	3, 158
Total	46, 627	41, 411	40, 517	44, 690	48, 346	51, 884	55, 186	58, 629

Available manpower—estimate for 1938: 54,500,000. See table I of Appendix 2. Estimated by projecting the estimates of labor force of the National Research Project, Works Progress Administration, according to the average annual rate of growth shown by the data for recent years, i. e., 600,000 additional per year.

[1] For the 1929 and 1935 values see table I of Appendix 2; the other values are assumed.

[2] For the 1929 and 1935 values see table I of Appendix 2; the other values are computed from the relation—

$$\underset{(1923\text{–}25=100)}{\text{Industrial production}}=0.2004\,(0.9837)^{\text{year}-1927}\;\underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})^{1.5284}},$$

derived using the data for the years 1919-36.

[3] Calculated values are based on the results of the analysis given in summary 1a of Appendix 2.

[4] Calculated values derived from the formula given in summary 2a of Appendix 2.

[5] Based on the formulas given in summaries 9a, 9b, and 9c of Appendix 2 and the formula connecting total railroad employment to man-hours in class I railways: Total employment=354,100−6,084 (year−1926) +0.0003471 (employee-hours in class I railways), using the data for the years of the period 1919–36.

[6] Includes the following industries: Manufactured gas, telegraph, telephone, electric light and power, post office, banking, finance, real estate, auto transport, and other transport. Values are calculated from—

$$\underset{(\text{thousands})}{\text{Employment}}=53.33\;\underset{(\text{Billions of 1936 dollars})}{(\text{consumer income average of current and previous year})}+233.34.$$

[7] Calculated from the regression—

$$\underset{(\text{millions})}{\text{Employment}}=0.112\;\underset{(\text{Billions of 1936 dollars})}{\begin{matrix}(\text{consumer income average current}\\ \text{and preceding year})\end{matrix}}+0.07\;(\text{year}-1928),$$

using the data from 1923–32. Income used for 1937 is 68 billions of 1936 dollars.

[8] See the discussion in Introduction of Appendix 2.

[9] Based on the relationship between man-days for all mining as given by the Bureau of Mines, Minerals Yearbooks, and industrial production—

$$\underset{(\text{Millions})}{\text{Calculated man-days}}=-79.6+2.133\;\underset{(1923\text{–}25=100)}{(\text{industrial production})}+42.25\,(0.8862)^{\text{year}-1929},$$

using the data from 1919–32.

Employment calculated by using an average days worked for the different levels of industrial production; the average days worked is given by—

$$\underset{(\text{average days worked})}{\text{Calculated}}=96-3.18\;(\text{year-}1927)+1.19\;\underset{(1923\text{–}25=100)}{(\text{industrial production})},$$

based on the years 1927–36.

[10] Based on formula—

$$\underset{(\text{Millions})}{\text{Total employment}}=46.8-73.91\;\underset{(1923\text{–}25=100)}{(\text{industrial production})^{0.1561}},$$

using the data for the years 1922–1932.

[11] Based on the formula—

$$\underset{(\text{Millions})}{\text{Employment}}=1.78+0.0855\;\underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})}.$$

[12] See remarks on construction in Introduction of Appendix 2; also footnote of the construction segment of table II of the body of report.

[13] See summary 800a in Appendix 2.

use, the analyses falling into group E have been used for the same reason as those falling in group C though the resulting patterns of resource use cannot be regarded as having the same degree of reliability in these segments as for other segments.

On the basis of the formulas derived from these analyses and using trend values for 1938, patterns of resource use have been developed and are presented in table 11.[4] In this table 6 patterns are presented giving consumption and employment for each of the 81 segments corresponding to each of 6 different levels of consumer income, ranging from 50 to 100 billions of

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[4] If trend values for any other year, say 1940, had been used, the resulting patterns would have been different due to the gradual changes taking place through time which are reflected in the formulae by the time factor.

TABLE 11.—*Patterns of resource use for the American economy consumption and employment*[1] *for 81 segments*

Code No.		Actual values for—		Assumed values					
		1929	1935						
	Consumer income [2] (billions of 1936 dollars)	65.3	56.9	50	60	70	80	90	100
	Corresponding industrial production [3] (1923-25=100)	119	90	68	90	113	139	166	195
		Actual patterns of resource use for [4]—		Calculated patterns of resource use assuming 1938 trend values [5]					
		1929	1935						
	SERVICES TO THE ECONOMY								
1a	Federal Government: Employment [6] (thousands)	580	790	940	940	940	940	940	940
2a	State and local government: Employment (thousands)	1,237	1,241	1,381	1,415	1,448	1,481	1,515	1,548
3a	Banking and finance: Employment [7] (thousands)	1,185	1,097	1,122	1,173	1,224	1,275	1,326	1,377
4	Post office:								
4b	Consumption [8] (deflated revenue, millions of 1929 dollars)	701	527	575	614	653	692	730	766
4a	Employment [9] (thousands)	282	260	282	282	282	282	282	282
5	Telephone:								
5b	Consumption (index of connections, 1920=100)	185	156	184	197	210	223	236	249
5a	Employment [10] (thousands)	427	292	336	348	360	372	384	396
6	Telegraph:								
6b	Consumption [11] (millions of equated messages)	240	170	171	201	230	259	287	315
6a	Employment [12] (thousands)	96	70	91	98	106	113	119	125
7	Electric light and power:								
7b	Consumption (billions of kilowatthours)	97.4	99.4	116.0	123.5	131.2	139.1	147.1	155.4
7a	Employment [13] (thousands)	272	231	277	288	301	314	326	340
8a	Manufactured gas: Employment (thousands)	65	51	42	49	57	64	71	79
9	Railroad transportation:								
9b	Passenger traffic, class I railways [14] (billions of revenue passenger-miles)	31.1	18.5	14.4	18.0	21.9	25.9	30.0	34 2
9c	Freight traffic, class I railways [15] (billions of net ton-miles)	492	311	237	315	400	493	590	695
9a	Total employment, all classes [16] (thousands)	1,816	1,113	906	1,079	1,263	1,458	1,652	1,867
10a	Auto transportation: Employment (thousands)	741	755	859	908	955	1,000	1,045	1,089
11a	Transportation: Other than auto and railroad—employment (thousands)	590	447	387	430	474	518	562	606
	MANUFACTURING								
101	Butter, cheese, condensed milk, ice cream:								
101b	Consumption (index of deflated value, 1929=100)	100	89.5	95.9	103.3	110.4	117.5	124.7	131.5
101a	Employment (thousands)	52	49	48	51	54	57	60	63
102	Meat packing:								
102b	Consumption [17] (millions of pounds—monthly average)	1,058	909	1,023	1,033	1,059	1,125	1,208	1,303
102a	Employment (thousands)	122	117	126	127	131	142	155	171
103	Flour milling:								
103b	Consumption (index of deflated value, 1929=100)	100	86.3	81.8	83.2	84.3	85.5	86.5	87.5
103a	Employment [18] (thousands)	27	26	24	25	25	25	25	26
104	Canning and preserving:								
104b	Consumption (millions of pounds)	4,096	4,753	4,133	4,766	5,400	6,033	6,666	7,300
104a	Employment [19] (thousands)	112	130	87	103	119	135	151	166
105	Tobacco, manufacturing:								
105b	Consumption (index 1923-25=100)	134	135	139	155	171	185	199	212
105a	Employment (thousands)	116	90	64	71	77	83	89	95
106	Sugar—extracting and refining:								
106b	Consumption [20] (millions of gross tons)	5.81	5.34	5.19	5.66	6.10	6.50	6.87	7.23
106a	Employment [21] (thousands)	24	26	24	25	25	26	26	26
107	Leather—tanned, curried and finished:								
107b	Consumption [22] (deflated value, millions of 1929 dollars)	439	354	120	272	380	460	520	568
107a	Employment [23] (thousands)	50	51	29	39	46	52	56	62
108	Bread and other bakery products:								
108b	Consumption (index of deflated value, 1929=100)	100	91.7	98.6	106.2	113.8	121.5	129.1	136.7
108a	Employment (thousands)	201	218	238	255	271	288	304	319
109a	Other foods: employment (thousands)	130	171	164	202	240	278	318	358
110	Confectionery and chocolate:								
110b	Consumption [24] (index of deflated value, 1929=100)	100	96.9	79.1	94.2	109 1	124.2	139.0	154.2
110a	Employment (thousands)	70	60	32	39	46	53	60	67
111	Boots and shoes:								
111b	Consumption [25] (deflated value, millions of 1926 dollars)	930	636	540	640	738	838	933	1,030
111a	Employment (thousands)	206	202	168	185	200	215	229	242
112	Leather products other than leather and boots and shoes:								
112b	Consumption [26] (deflated value, millions of 1926 dollars)	459	341	250	326	408	497	590	690
112a	Employment (thousands)	63	58	42	51	61	70	80	90
113	Woolen and worsted goods:								
113b	Consumption (index of deflated value, 1929=100)	100	91	56	68.9	82.2	95.7	109.4	123.6
113a	Employment (thousands)	147	158	70	91	114	139	166	194
114	Cotton textiles:								
114b	Consumption [27] (index of consumption of raw cotton, 1923-25=100)	114	91	79	96	113	130	147	164
114a	Employment [28] (thousands)	425	369	236	305	379	449	519	588
115	Silk and rayon goods:								
115b	Consumption [29] (index of deflated value, 1929=100)	100	103.7	134	168	203.4	239.2	277.9	317
115a	Employment (thousands)	130	126	101	117	132	148	162	177
116	Rayon:								
116b	Consumption [30] (millions of pounds)	131	253	372	372	372	372	372	372
116a	Employment (thousands)	39	51	45	45	45	45	45	45

See footnotes at end of table.

TABLE II.—*Patterns of resource use for the American economy consumption and employment for 81 segments*—Continued

Code No.		Actual patterns of resource use for —		Calculated patterns of resource use assuming 1938 trend values					
		1929	1935						
	MANUFACTURING—continued								
118	Knit goods:								
118b	Consumption (index of deflated value, 1929=100)	100	110.7	127.4	139.9	151.5	162.6	172.3	182.0
118a	Employment [31] (thousands)	208	220	178	199	218	237	254	271
119	Wearing apparel.								
119b	Consumption (millions of 1926 dollars)	3,952	2,965	3,404	3,890	4,416	4,966	5,546	6,138
119a	Employment [32] (thousands)	537	574	500	570	650	730	820	910
120a	Dyeing and finishing: Employment (thousands)	79	75	72	84	96	105	118	129
120.1	Other textiles:								
120.1b	Consumption [33] (millions of 1926 dollars)	1,533	1,289	1,047	1,337	1,629	1,950	2,270	2,612
120.1a	Employment [34] (thousands)	181	166	112	142	172	206	240	277
121	Paper and pulp:								
121b	Consumption (ten thousand net tons)	1,335	1,262	1,126	1,346	1,566	1,819	2,061	2,314
121a	Employment [35] (thousands)	128	127	90	107	129	154	182	210
122	Lumber and millwork:								
122b	Consumption (millions of board feet)	333	172	86	151	219	296	376	462
122a	Employment [36] (thousands)	510	304	135	222	312	410	512	608
123	Paper products:								
123b	Consumption (millions of 1926 dollars)	780	805	692	847	1,007	1,167	1,330	1,496
123a	Employment (thousands)	105	109	84	99	113	127	141	155
124	Furniture and related products:								
124b	Consumption [37] (millions of 1926 dollars)	998	549	508	740	1,000	1,282	1,629	1,928
124a	Employment (thousands)	199	134	109	160	218	279	356	421
125a	Miscellaneous lumber products: Employment (thousands)	154	137	89	119	151	189	224	265
126	Printing and publishing, newspaper and periodical:								
126b	Consumption (index of deflated value, 1929=100)	100	87.4	102.4	115.6	130.4	143.6	159.6	174.4
126a	Employment (thousands)	130	119	118	128	138	148	160	170
126.1	Printing and publishing, book, music and job:								
126.1b	Consumption (millions of 1936 dollars)	841	711	697	833	969	1,106	1,243	1,379
126.1a	Employment (thousands)	151	127	110	135	162	190	218	246
126.2	Printing and publishing, allied industries:								
126.2a	Employment (thousands)	77	59	67	74	81	88	95	102
127	Rubber tires and tubes:								
127b	Consumption [38] (millions of weighted aggregates of tires and tubes)	674	466	398	521	622	723	812	898
127a	Employment [39] (thousands)	83	57	36	47	56	65	74	81
128	Rubber products other than tires and tubes:								
128b	Consumption (deflated value, millions of 1926 dollars)	256	250	213	266	317	373	428	537
128a	Employment (thousands)	66	58	40	68	89	109	125	152
129	Chemicals:								
129b	Consumption (index of deflated value, 1929=100)	100	90.7	86.5	107.8	129.8	153.3	177.4	202.4
129a	Employment (thousands)	196	188	160	189	214	240	265	290
129.1	Paints and varnishes:								
129.1b	Consumption (index of deflated value, 1929=100)	100	86.6	61.6	86.2	110.7	135.3	159.9	184.5
129.1a	Employment (thousands)	29	28	20	26	32	38	44	50
131	Petroleum refining:								
131b	Consumption (millions of barrels)	988	966	969	1,116	1,263	1,410	1,558	1,705
131a	Employment (thousands)	80	77	76	81	86	90	95	100
131c	Gasoline: Consumption [40] (millions of barrels)	376	433	525	594	665	740	818	902
132	Glass:								
132b	Consumption [41] (deflated value, millions of 1926 dollars)	319.7	309.5	238.2	290.4	341.2	395.4	448.7	502.3
132a	Employment [42] (thousands)	68	67	40	47	54	60	67	74
133	Cement:								
133b	Consumption [43] (millions of barrels)	170.7	75.4	114.4	142.0	168.4	194.5	220.4	248.0
133a	Employment (thousands)	33	21	22	27	32	37	42	48
134	Clay products, other than pottery:								
134b	Consumption [44] (index of deflated value. 1929=100)	100	36.7	29.5	47.1	64.3	92.5	120.2	154.0
134a	Employment (thousands)	94	45	28	42	57	83	107	135
134.1	Pottery:								
134.1b	Consumption (millions of 1926 dollars)	114.3	79.0	50.5	72.6	98.9	129.1	163.3	201.4
134.1a	Employment (thousands)	35	29	17	24	31	40	50	60
134.2a	Marble, granite and stone, and other glass products, n. e. c.: Employment (thousands)	98	72	31	50	76	109	150	200
135	Fertilizer:								
135b	Consumption [45] (millions of tons)	79.7	62.2	71.0	71.0	71.0	71.0	71.0	71.0
135a	Employment [46] (thousands)	21	17	17	17	17	17	17	17
136	Coke:								
136b	Consumption [47] (millions of net tons)	52.0	26.3	21.1	31.8	45.1	63.0	85.0	112.9
136a	Employment [48] (thousands)	21	17	14	18	23	28	33	39
137	Iron and steel:								
137b	Consumption (millions of gross tons)	51.3	31.7	15.7	31.7	48.5	67.4	87.1	108.2
137a	Employment [49] (thousands)	420	375	163	282	398	515	630	748
138	Nonferrous metals, other than copper, smelting and refining:								
138b	Lead consumption (thousands of tons)	972	543	369	542	748	993	1,271	1,585
138c	Zinc consumption (thousands of tons)	634	461	282	439	628	869	1,148	1,479
138d	Nonferrous metals, other than copper, lead, and zinc: Consumption (weighted index, 1926=100)	136.9	99.2	71.0	129.0	190.0	258.1	329.1	405.4
138a	Employment: [50] Smelting and refining (thousands)	22	17	13	19	22	24	25	26
138.1	Copper:								
138.1b	Consumption (thousands of net tons)	889	426	218	445	722	1,109	1,608	2,252
138.1a	Employment: [51] Smelting and refining (thousands)	145	104	33	88	111	121	130	130
139	Iron and steel products:								
139b	Consumption [52] (millions of 1926 dollars)	3,000	2,310	1,540	2,320	3,220	4,340	5,620	7,100
139a	Employment [53] (thousands)	461	351	211	317	438	589	764	964
140a	Nonferrous metal products: Employment (thousands)	279	238	146	224	317	434	569	728
141	Automobiles:								
141b	Consumption:[54] Passenger car sales (thousands)	3,850	3,480	1,300	2,390	3,640	5,270	7,280	10,350
141c	Consumption:[55] Commercial car sales (thousands)	527	511	320	561	885	1,340	1,914	2,642
141a	Employment [56] (thousands)	447	388	197	291	395	519	664	860
143a	Transportation equipment, other than automobiles: Employment (thousands)	136	93	45	69	98	132	173	220
144a	Electrical machinery: Employment (thousands)	283	180	105	167	247	348	469	614
145	Machinery, excluding electrical:								
145b	Consumption (millions of 1926 dollars)	4,431	3,494	1,730	3,300	4,880	6,450	8,020	9,600
145a	Employment (thousands)	786	577	214	466	695	920	1,145	1,374
146a	Miscellaneous manufacturing industries: Employment (thousands)	322	249	143	106	253	318	388	464

See footnotes at end of table.

TABLE II.—*Patterns of resource use for the American economy consumption and employment for 81 segments*—Continued

Code No.		Actual patterns of resource use for —		Calculated patterns of resource use assuming 1938 trend values					
		1929	1935						
	MINERALS								
201	Crude petroleum and natural gas:								
201b	Output [57] (thousands of wells drilled)	26.4	21.4	20.4	23.3	25.9	28.6	31.0	33.4
201a	Employment (thousands)	140	109	109	123	135	147	159	170
202	Bituminous coal:								
202b	Consumption [58] (millions of net tons)	520	360	293	356	426	499	573	649
202a	Employment [59] (thousands)	460	353	299	345	395	448	502	556
203	Anthracite coal:								
203b	Consumption [60] (millions of net tons)	71.5	50.0	59.4	66.4	73.0	79.1	84.9	90.6
203a	Employment [61] (thousands)	147	78	87	108	124	140	156	172
204	Other nonmetallic mining:								
204b	Consumption [62] (index 1929=100)	100	74.5	59.4	83.4	109.6	140.3	173.4	209.9
204a	Employment [63] (thousands)	96	44	33	45	58	75	93	113
205b	Metallic ores: Metal mining, iron ore (consumption, millions of gross tons)	73.0	30.5	6.1	30.9	57.0	86.4	117.0	149.7
206b	Nonferrous metallic ores: Consumption (millions of current dollars)	587	291	94	247	440	693	1,002	1,381
206.1a	Metal mining: Employment [64] (thousands)	120	80	41	69	96	136	179	232
	BULK DISTRIBUTION AND CONSTRUCTION								
301a	Wholesale trade: Employment (thousands)	1,670	1,350	1,320	1,510	1,620	1,730	1,860	1,980
302a	Business service: Employment (thousands)	260	252	291	323	356	388	423	457
401a	Retail trade: Employment (thousands)	5,468	4,970	4,530	5,150	5,770	6,390	7,020	7,640
500	Construction:								
500b	Consumption [65] (deflated value, billions of 1929 dollars)	6.44	2.42	4.10	5.89	7.67	9.43	11.18	12.94
500a	Employment [66] (thousands)	1,543	719	1,052	1,271	1,452	1,605	1,742	1,862
	SERVICES TO THE CONSUMER								
601a	Public education: Employment (thousands)	1,134	1,152	1,245	1,245	1,245	1,245	1,245	1,245
602a	Private education: Employment (thousands)	207	207	232	232	232	232	232	232
603a	Professional service: [67] Employment (thousands)	1,218	1,337	1,413	1,430	1,446	1,463	1,480	1,496
604a	Personal service: Employment (thousands)	1,617	1,488	1,671	1,816	1,968	2,113	2,270	2,415
605a	Domestic service: [68] Employment (thousands)	2,257	1,823	1,470	1,716	2,023	2,280	2,560	2,806
606a	Recreation and amusement: Employment (thousands)	247	232	197	235	273	311	349	387
607a	Miscellaneous consumers' services: Employment (thousands)	311	324	366	395	425	454	484	513
	MISCELLANEOUS								
800a	Miscellaneous industries: Employment (thousands)	2,390	2,029	2,012	2,249	2,357	2,538	2,776	3,158
801a	Non-wage-earners in mining and manufacturing: Employment (thousands)	1,733	1,386	1,440	1,562	1,695	1,838	1,982	2,148
900a	Agriculture: [69] Employment (thousands)	9,888	9,925	10,100	10,100	10,100	10,100	10,100	10,100
	Employment: All segments [70] (thousands)	46,624	41,409	39,461	43,388	47,234	51,258	55,534	60,084
	Estimated available manpower for 1938=54,500,000.[71]								

NOTE.—The calculated patterns for 1938 are not all of equal reliability; see charts XXI-LVI for the group letter indicating the degree of reliability of each analysis.

[1] In most of the manufacturing segments man-hours was used to represent manpower and the equivalent full time employment shown for such segments was computed on the basis of an assumed 40 hour week. For nonmanufacturing segments the figures shown are equivalent full time employment for all persons engaged. For the definitions see *National Income of the United States, 1929-35*, 1929–35, p. 30, Department of Commerce.

[2] For the actual values see table 1 of Appendix 2; the other values are assumed levels of buying power which were used to calculate the patterns of resource use.

[3] Corresponding industrial production values were calculated from the assumed values of values of consumer income by use of the formula:

$$\underset{(1923\text{–}25=100)}{\text{Calculated industrial production}}= 0.2004\ (0.9837)^{\text{year}-1927}\ \underset{(\text{Billions of 1936 dollars}}{(\text{consumer income}))}^{1.5184};$$

the formula was obtained for the years of the period 1919–36 by the method of least squares.

[4] The actual values for 1929 and 1935 are given in the individual summaries and table II of Appendix 2.

[5] The calculated values are derived from the formulas given in each summary using the assumed values of consumer income and of the corresponding industrial production. Other assumptions which are made in the calculation of the values are stated in the footnotes corresponding to the segment. In many of the manufacturing and mining segments manpower is calculated from production and a time trend; production in turn is derived from the calculated consumption. Unless otherwise indicated in the footnotes below, production was taken equal to consumption (a discussion of this is given in the introduction to section II of Appendix 2.)

[6] The value given at each level of consumer income was obtained by projecting the trend shown in employment for the years 1933–36.

[7] Based on a regression equation using the data for the years of the period 1929–36, i. e.,

$$\underset{(\text{Thousands})}{\text{Calculated employment}}=520+10.2\ \underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})}.$$

[8] Deflated index of postal rates is assumed to be the same as in 1936, i. e., 195.8.

[9] Deflated revenue for 1937 was calculated to be 631 millions of 1929 dollars derived by the formula given in summary No. 4b.

[10] Index of output in 1937 was taken to be 195.8 which was calculated from the formula given in summary No. 5b.

[11] Assumed real cost per equated message 66.2 (1936 cents) for the average of 1937 and 1938; this was the same as the average for 1935 and 1936.

[12] 1937 operating revenue calculated as 166.7 hundreds of millions of dollars assuming 66.2 as the deflated revenue per message. Revenue is calculated by multiplying real cost per message times cost of living times number of messages.

[13] Output for 1937 was taken to be 121.0 billions of kilowatt-hours.

[14] The deflated revenue per passenger-mile is assumed to be as of 1937, i. e., 1.73 (1936 cents). Values calculated from regression using all the data 1920–37.

$$\underset{(\text{Billions})}{\text{Calculated passenger miles}}=0.4303\ (0.9215)^{\text{year}-1926}\times \underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})}^{1.3533}\underset{(\text{Cents})}{(\text{real passenger rates})}^{-0.937}.$$

[15] Industrial production for year ending in September of 1938 for the different levels of consumer income assumed to be the same as for the calendar year. The formula in summary No. 9b gives for the different income levels the following revenue net ton-miles (in billions): 212, 284, 361, 448, 538, and 637. Revenue and nonrevenue net ton-miles were determined from the regression using the data for the years 1920–36:

$$\underset{(\text{Billions})}{\text{Revenue and nonrevenue ton-miles}}=1.097\ \underset{(\text{Billions})}{(\text{revenue ton-miles})}+3.$$

[16] The formula given in summary No. 9a was used to calculate employee hours in class I railways, i. e., 1760, 2240, 2750, 3280, 3820, and 4400 (million employee hours), for the respective levels of passenger-miles and net ton-miles. The employment for all railways was calculated from the following regression formula, using the data for the years of the period 1919–36:

$$\text{Persons engaged}=354100-6{,}084\ (\text{year}-1926)+0.0003471\ \underset{(\text{Class I})}{(\text{employee hours})}.$$

The total persons engaged are from the Department of Commerce 1929–36 and spliced with the data of the National Bureau of Economic Research, 1920–29.

[17] Real price of meat computed from a relationship between consumer income and real price of meat, i. e.,

$$\text{Index of real price of meat}=194-27162\ \underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})}^{-1.3307}.$$

The values obtained for the different levels of consumer income were 76, 100, 122, 134, 140, and 142 on a 1926 base deflated by cost of living on a 1936 base.

Real nonagricultural income was computed from the regression:

$$\underset{(1929=100)}{\text{Real nonagricultural income}}=10.6+1.36\ \underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})},$$

yielding the values for 1938 of 78.6, 92.2, 105.8, 119.4, 133.0, and 146.6 (1929=100) for the various assumed levels of consumer income.

[18] To obtain more reliable values the trend factor given in the formula of the summary No. 103a was revised, using the selected point method, to: $0.677+0.173\ (0.9713)^{\text{year}-1926}$; this gave 0.730 for the value of the trend factor in 1938.

[19] The production used was calculated from consumption by utilizing the regression equation:

$$\underset{(1919=100)}{\text{Calculated production}}=1.296\ \underset{(1919=100)}{(\text{consumption})}-34.048.$$

The calculated production values for 1938 were: 176.0, 208.2, 240.3, 272.6, 304.7, and 333.9. Consumption for the base year 1919 was 2,557 million pounds.

[20] Real retail price of sugar taken as 6.60 (1929 cents per pound), the value for 1936.

[21] Production of cane sugar was calculated from the consumption of sugar by the formula:

$$\underset{(1929=100)}{\text{Production}}=-36.2+24.6\ \underset{(\text{Million gross tons})}{(\text{sugar consumption})}-2.43\ (\text{year}-1926),$$

derived from the data for the years 1919–32.

The number of man-hours per week in the base year 1929 was 832,000. To the cane sugar employment were added 12,000 wage earners to cover the beet sugar refining and the cane sugar production industries estimated on the basis of the projection to 1938 of a time trend.

[22] The price index for other leather products was assumed to be 108; for boots and shoes 121.3, the values for the year 1936. The deflated value of consumption of leather in 1937 was calculated as 404 millions of 1926 dollars, based upon a consumption in 1936 of 374 millions of 1926 dollars.

[23] The index of leather, tanned, curried, and finished, was computed from leather available for consumption according to the formula:

$$\underset{(1923\text{–}25=100)}{\text{Leather production}}=30.9+0.1644\,\underset{(\text{Millions 1926 dollars})}{(\text{leather consumption})}+1.8\,(\text{year}-1932),$$

derived from the data for the years 1928–35.

[24] The real price index was assumed to be 86.3, approximately as in 1936.

[25] Price assumed to be 121.3, as of 1936.

[26] The deflated price index was taken to be 108 (1926=100), the value for the year 1936.

[27] The rate of change of the cotton goods price index was taken as 114, to account for an assumed increase in prices; the deflated price of raw cotton was assumed to be 86.1 (1926=100) as in 1936.

[28] Production was calculated from consumption using the formula:

$$\underset{(1923\text{–}25=100)}{\text{Production}}=0.954\,\underset{(1923\text{–}25=100)}{(\text{consumption})}-16.2$$

derived graphically from the data for the years 1921–35.

[29] The index of consumption for 1937 was taken as 103.2 (1929=100) derived from 11 months' data from the *Survey of Current Business.*

[30] Computed from a formula in which all the data 1925–36 were used:

$$\underset{(\text{Millions of pounds})}{\text{Calculated consumption}}=102.4\,(1.154)^{\text{year}-1929}\times(1.156)^{\text{cycle factor}}.$$

[31] Production derived from consumption by the formula:

$$\underset{(1929=100)}{\text{Calculated production}}=4.4+0.960\,\underset{(1929=100)}{(\text{consumption})}.$$

The calculated values for 1938 were: 126.7, 138.7, 149.8, 160.5, 169.8, and 179.1 on a 1929 base.

[32] Values obtained by reworking the formula given in summary No. 119a using the data 1929–35:

$$\underset{(\text{Millions/week})}{\text{Calculated man-hours}}=-0.04+0.00591\,\underset{(\text{Millions of 1926 dollars})}{(\text{deflated output})}.$$

[33] The 2-year average of real price for 1938 is taken to be 86.4 (1929=100), the value for the year 1936.

[34] Production derived from consumption by means of the formula:

$$\underset{\substack{(\text{Millions of}\\ \text{1926 dollars})}}{\text{Production}}=77.7+0.846\,\underset{\substack{(\text{Millions of}\\ \text{1926 dollars})}}{(\text{consumption})}+0.047\,(1.101)^{\text{year}-1931}$$

Production derived from consumption by the formula:

$$\underset{(1929=100)}{\text{Production}}=\left[\frac{4796+\underset{(\text{Ten thousand net tons})}{(\text{consumption})}}{2250}\right]^{4.5593}$$

[36] Production derived from consumption by the formula:

$$\underset{\substack{(\text{Millions of}\\ \text{board feet})}}{\text{Production}}=4.7+1.023\,\underset{\substack{(\text{Millions of}\\ \text{board feet})}}{(\text{consumption})}$$

derived from the data for the years 1920–35.

[37] The construction values used for the different levels of consumer income were derived from the formula given in summary No. 500a. The values of construction in billions of 1929 dollars were: 4.10, 5.89, 7.67, 9.43, 11.18, and 12.94.

[38] Change in registrations was obtained from the consumer income by the formula:

$$\underset{(\text{Millions})}{\text{Change in registration}}=7.253-694.5\,\underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})}^{-1.1733}$$

[39] The production index is obtained from the estimates of domestic shipments of tires and tubes according to the formula:

$$\text{Production index}=-1+.21\,\underset{(\text{Millions})}{(\text{shipments}-\text{weighted aggregate})}$$

derived graphically from the data for the years 1923–36. The values of the production index so obtained were 83, 108, 130, 161, 170, and 188 for the respective levels of consumer income.

[40] Equated cars were calculated from the relationship:

$$\underset{(\text{Ten thousands})}{\text{Equated cars}}=2089-1209\,(0.9101)^{\text{year}-1930}+44\,\underset{\substack{(\text{Average current and}\\ \text{2 previous years})}}{(\text{consumer income})}$$

[41] The deflated price of glass was taken to be 114.6, the value for the year 1936.

[42] Net exports assumed to be 3.0 millions 1920 dollars, to be added to consumption to obtain production.

[43] Construction values for 1938 were calculated from the formula given in summary No. 500a.

[44] Construction values for 1938 derived from the formula given in summary No. 500a.

[45] Cash crop income for 1937 was taken as 76.3 (1924–29=100); prices paid by farmers for 1937 as 131 (1909–14=100); deflated cash crop income for 1937 as 92.1 (1929=100). The ratio of prices received to prices paid for 1938 was taken to be 94 (1909–14=100), the value for the year 1937.

[46] Production was calculated from the relation:

$$\underset{(\text{Millions of tons})}{\text{Production}}=2.4+1.20\,\underset{(\text{Millions of tons})}{(\text{consumption})}-0.49\,(\text{year}-1926)$$

derived graphically from the data for the years 1920–35.

[47] Coke consumed for domestic purposes calculated by assuming price ratio of coke to coal for 1938 to be the same as the average for the period 1928–35, viz., 86.5 (1923–25=100). See summary 136c. The calculated values of coke consumed for industrial purposes are 2.6, 11 2, 23.1, 40.2, 62.3, 91.4 millions of tons. See summary No. 136b. Pig iron production is calculated from iron and steel production by the formula:

$$\underset{(\text{Millions of gross tons})}{\text{Calculated production of pig iron}}=$$

$$4.9+0.330\,\underset{(1923\text{–}25=100)}{(\text{iron and steel production})}-1.10\,(\text{year}-1926)$$

using the data for the years 1925–32. Iron and steel production is calculated as described in footnote No. 49.

[48] Coal consumed in the manufacture of coke was derived from the formula:

$$\underset{(\text{Millions of tons})}{\text{Calculated coal consumed}}=2.2+1.502\,\underset{(\text{Millions of net tons})}{(\text{coke consumed for all purposes})}$$

[49] Production of iron and steel derived from consumption from the relation:

$$\underset{(1923\text{–}25=100)}{\text{Calculated production}}=2.746\,(0.993)^{\text{year}-1926}\times\underset{(\text{Millions of gross tons})}{(\text{consumption})}^{0.9791}.$$

Consumption is calculated from the following formula, using all of the data 1923–1936:

$$\underset{(\text{Millions of gross tons})}{(\text{Calculated consumption})}=33.81+0.0045\,(\text{year-1930})+0.72806\,\underset{(1923\text{–}25=100)}{(\text{industrial production})}$$

[50] Consumption corresponding to the estimates of manpower was spread through three analyses: Lead consumption, zinc consumption, and the consumption of nonferrous metals other than copper, zinc, and lead. These were combined into an index with constant weights based on 1929 values. The weights used for lead, zinc, and "other" were 11.23, 9.18, and 20.69, respectively. This series was reduced to a 1926 base giving an index of "nonferrous metals other than copper" consumed. The production index was derived from this consumption index by the formula:

$$\underset{(1929=100)}{\text{Calculated production}}=1.6+0.8546\,\underset{(1926=100)}{(\text{consumption index})}-0.3997\,(\text{year}-1926)$$

based on the data for the period 1919–32.

[51] Production calculated from consumption by the formula:

$$\underset{(\text{Thousands of tons})}{\text{Copper production}}=72+1.982\,\underset{(\text{Thousands of tons})}{(\text{copper consumption})}$$

based on the data for the period 1919–32.

[52] The deflated price index for 1938 was taken to be 102.5 (1926=100), the value for 1936. For extrapolation the formula was reworked using the data for the period 1919–36 giving:

$$\underset{(\text{Millions of 1926 dollars})}{\text{Calculated consumption}}=184\,(1.0073)^{\text{year}-1926}\times\underset{(1923\text{–}25=100)}{(\text{industrial production})}^{1.4478}\times$$

$$\underset{(1926=100)}{(\text{deflated price of iron and steel products})}^{-0.6776}$$

[53] Production was derived from:

$$\underset{\substack{(\text{10 millions of}\\ \text{1926 dollars})}}{\text{Calculated production}}=1.038\,\underset{\substack{(\text{10 millions of}\\ \text{1926 dollars})}}{(\text{consumption})}-2$$

yielding estimates for production for 1938: 158, 239, 332, 448, 681, and 735 ten millions of 1926 dollars.

[54] The real income of nonwage-earners, taken to be 42, 49, 57, 65, 73, and 80 billion 1936 dollars for the various levels of consumer income, obtained from the formula

$$\underset{(\text{Billions of 1936 dollars})}{\text{Real nonwage-earners' income}}=0.7778\,\underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})}+2.67$$

derived graphically from the data for 1919–36. Wage-earners' income was obtained by subtraction. The number of cars 7 years old and older on January 1, 1938, was estimated from life tables and registrations to be 7,490,000.

[55] The commercial car sales (new car registrations) were derived from the formula:

$$\underset{(\text{Thousands})}{\text{Sales}}=0.04724\times(0.9976)^{\text{year}-1931}\times\underset{(1923\text{–}25=100)}{(\text{industrial production})}^{1.759}\times$$

$$\underset{(\text{Millions})}{(\text{number of cars 4 years or older})}^{1.73}$$

using the data for the years of the period 1925–36, omitting the years 1927 and 1928. The number of cars 4 years or older was based on a 4-year life table applied to commercial cars sold for 8 previous years and these subtracted from commercial cars in use at the end of the year. The method used was similar to that used for passenger cars—see summary No. 141b.

[56] Production is the sum of passenger car sales, commercial car sales, and net exports. Net exports are taken at 350,000 cars, the value for the year 1936.

[57] Assumed price of crude petroleum same as 1936: 55.5 on a 1926 base; calculated from the following formula, using all of the data for the years of the period 1919–1936:

$$\underset{(\text{Thousands})}{\text{Calculated wells drilled}}=.1391\,(1.02)^{\text{year}-1926}\times\underset{(1923-25=100)}{(\text{industrial production})}^{0.4676}\times$$

$$\underset{(1926=100)}{(\text{crude oil prices})}^{0.6944}$$

[58] Assumed 1938 efficiency index 64.0 on a 1929 base, obtained by projecting trend of efficiency factor. Assumed 1938 price ratio (coal and fuel oil) same as value for 1936: 145.3.

[59] Employment was derived from man-days by the equation:

$$\underset{(\text{Thousands})}{\text{Calculated employment}}=114.5+3.9113\,\underset{(\text{Millions})}{(\text{man-days})}-0.588\,(\text{year}-1026).$$

1938 figures for man-days were calculated to be 49.1, 60.7, 73.6, 87.1, 100.8, and 114.8 millions, respectively. Production was derived from consumption by the formula:

$$\underset{(\text{Millions of tons})}{\text{Underground production}}=286+1.05\,\underset{(\text{Millions of tons})}{(\text{consumption}-300)}.$$

Calculated production for 1938: 279, 345, 418, 495, 573, and 652 millions of tons. Size of mine assumed to be the same in 1938 as in 1936: 330 tons per mine per year.

[60] Assumed ratio of price of coal to competing fuels in 1938 same as in 1936, 103.9 on a 1926 base.

[61] Wage earners estimated from man-days by the following formula:

$$\underset{(\text{Thousands})}{\text{Calculated wage earners}}=80+4.7\,\underset{(\text{Millions})}{(\text{man-days}-20.0)}$$

Calculated 1938 man-days: 21.6, 25.9, 29.4, 32.8, 36.1, 39.4, millions of man-days, respectively. Production is derived from consumption (shown in table) by the formula:

$$\underset{(\text{Millions of gross tons})}{\text{Production}}=44.0+1.07\,\underset{(\text{Millions of net tons})}{(\text{consumption}-50)}$$

[62] Construction values are obtained from the formula shown in summary No. 500a.

[63] The index of man-hours (1929=100) as calculated by the formula given in summary No. 202a it 35.8, 49.4, 64.7, 83.2, 103.8, and 126.5 for the respective levels of consumer income. Wage earners were obtained from the formula:

$$\underset{(\text{thousands})}{\text{Wage earners}}=0.9+0.889\,\underset{(1929=100)}{(\text{man-hours index})},$$

derived graphically from the data for the years 1919-35. The production index is obtained from the consumption index by the formula:

Production index = 11.5 + 0.8772 (consumption index),
(1929 = 100) (1929 = 100)

derived graphically from the data for the years 1919–35.

[64] This set of estimates was made by relating employment (wage earners) in all metal mining to man-hours in all metal mining adding the 1938 estimates for ferrous and nonferrous metal mining: Estimates for 1938 (millions of man-hours):

Consumer income (assumed)	50	60	70	80	90	100
Iron mining	7.2	25.2	40.4	55.5	70.2	84.9
Nonferrous mining	36.4	82.7	141.0	218.0	311.0	426.0
All metal mining	43.6	107.9	181.4	273.5	381.2	510.9

Employment was computed by the formula:

Calculated employment = 26 + 0.402527 (man-hours).
(Thousands) (Millions)

Iron ore man-hours was related to production as described in summary No. 205a and production was derived from consumption of iron and steel (as in table) by the ormula:

Calculated production of merchantable ore =
(Millions of tons)

1.141 (iron and steel available for domestic consumption)$^{1.203696}$ × (0.9601)$^{\text{year}-1926}$
(Millions of gross tons)

Man-hours for nonferrous metal mining were related to production of all nonferrous ores according to the formula in summary No. 206a. Production of ore was related (see summary No. 206) to all nonferrous metal smelted, by the formula:

Calculated consumption of ore =
(Millions of dollars)

22 + 0.60698 (production of refined nonferrous metals) − 11.8694 (year–1926),
(Millions of dollars)

yielding the following production estimates for 1938: 94, 247, 440, 693, 1,002, and 1,381 millions of dollars. The smelting and refining of all nonferrous metals was made up of a weighted aggregate of refined copper (thousands of tons×360) and "other nonferrous metals" (see summary No. 138a) with weights 360 and 326 respectively.

[65] Cost of construction assumed to be the same as in 1936: 99.1 on a 1929 base.

[66] Employment calculated using formula shown in summary No. 500b. Estimated values for 1938: 4.10, 4.89, 7.67, 9.43, 11.18, and 12.94 billions of 1929 dollars, deflated value of contracts. The 3-year-moving average is calculated from a linear relationship between deflated value of the current year and deflated value (3-year-moving average using the data for the years 1920–34). The relationship is:

Calculated deflated value (3-year-moving average) =
(Billions of 1929 dollars)
0.69 + 0.8787 (deflated value current year).
(Billions of 1929 dollars)

[67] Population for 1938 is taken as 130 million, the projection of the trend shown in previous years.

[68] Nonwage-earners' consumer income for 1938 estimates at 42, 49, 57, 65, 73, and 80 billions of 1935 dollars derived as indicated in footnote 54.

[69] Employment taken as of 1936; for a discussion of this see introduction to Appendix 2.

[71] Estimated from preliminary unpublished estimates of National Research Project of the Works Progress Administration by projecting according to the average annual rate of growth as shown by the data for recent years. See table I of Appendix 2.

1936 dollars.[5] In preparing this table, the assumption has been made that industrial production bears the same relation to consumer income that it has borne on the average in recent years.[6] Specific assumptions which have been made at various points as, for instance, the ratio of fuel oil to bituminous coal prices, are set forth in the footnotes.

Consumer income corresponding to full employment.—These two sets of patterns, based respectively on 11 and 81 segments, give an approximate basis for considering the question with which this report begins, namely, what is the level of economic activity which would absorb practically the whole of the great army of unemployed. A step toward answering this question can be taken by comparing the employment indicated at the different levels of consumer income with the total manpower available. Such a comparison is made in chart XVIII. The solid line in the center of the chart represents the total employment which would be called for at different levels of consumer income as estimated from the analysis of 11 segments, while the dotted line represents the total employment at different levels as estimated from the 81 segment analysis using 1938 trend values. In both cases, the estimates are based on a 40-hour work week. The results of the two different analyses coincide fairly closely with each other and with the results obtained from the analysis shown in chart XIX, in which the whole economy is treated as a single segment.[7] Presumably the analysis based on 81 segments is the more reliable. The latter runs from a total employment equivalent to the full-time activity of only 39.5 million persons at a consumer income of 50 billion dollars (1936 dollars) to 60.1 million people at a consumer income of 100 billion.

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[5] The estimates of activity for the individual segments at the 100-billion-dollar level are likely to be most unreliable since the errors resulting from extrapolations beyond existing data would presumably increase. However, the estimates corresponding to this level are given in order to exaggerate any inconsistencies between the series of calculated values so that they can be more readily located. It is to be pointed out that the estimates derived from formulas for related industries should be tested for inconsistencies. For example, when the assumed consumer income is increased from 50 to 100 billion dollars, the figure for calculated production of iron and steel increases from 15.7 to 108.2 millions of gross tons, or by approximately seven times, whereas the consumption of iron ore increases from 6.1 to 149.7 millions of tons, or by approximately 24.5 times. This discrepancy may be explained by the fact that both pig iron and scrap steel are used in the making of steel products and that during periods of depression scrap iron prices are low compared to the cost of making pig iron and hence a smaller proportion of steel is made from pig iron; on the other hand, during periods of prosperity scrap iron prices are high relative to the cost of pig iron and a larger proportion of pig iron is used in steel-making. The wider fluctuation in the production of pig iron is thus in turn reflected in the wider fluctuation of iron ore consumption. Another example is that relating to flour consumption and the production of bread and bakery products. According to the formula, when the assumed consumer income is increased from 50 to 100 billions of dollars, the calculated flour consumption increases only by 7 percent, whereas the production of bread and bakery products increases by about 38 percent. Here again the discrepancy can be explained in part by the fact that the production of bread and bakery products includes only the manufactured products, and no account is taken of the bread and bakery products made in the homes. Since it may be presumed that when the consumer income is low, more home-made bread is consumed, it would thus appear that while the consumption of flour would be relatively stable, the consumption of manufactured bread and bakery products would fluctuate considerably with depression and prosperity. It can be further explained by the fact that the index of production of bread and bakery products includes both bread and such products as cakes and cookies which use less flour in proportion to their value than does bread. Presumably the production of this type of product is more influenced by changes in consumer income than is bread. Such inconsistencies as these require investigation and in each case it is important to determine whether the inconsistencies can be explained, or whether they are due to faulty formulae or analyses.

[6] The corresponding figures of consumer income and industrial production and the formula used in relating them are given in table II.

[7] Total employment in the economy and consumer income are related by the following regression obtained from the data given in table I of Appendix 2 for the years of the period 1921-36:

Calculated employment = 18.17 − 0.2132 (year-1927) + 0.4371 (consumer income)
(Millions, full-time equivalent) (Billions of 1936 dollars)

The average percent residual (actual less calculated employment expressed as a percent of the calculated) for the period considered is 0.9 percent, with the absolute maximum of 1.7 percent occurring in 1922. The following table gives a comparison by three methods of approach of the employment calculated for different levels of consumer income using the value for 1938 for the time factor:

Consumer income (billions of 1936 dollars)	50	60	70	80	90	100
	(Employment in millions)					
Employment calculated from 11 segment analyses	40.5	44.7	48.3	51.9	55.2	58.6
Employment calculated from whole economy considered as 1 segment	37.7	42.1	46.4	50.8	55.2	59.6
Employment calculated from 81 segment analyses	39.5	43.4	47.2	51.3	55.5	60.1

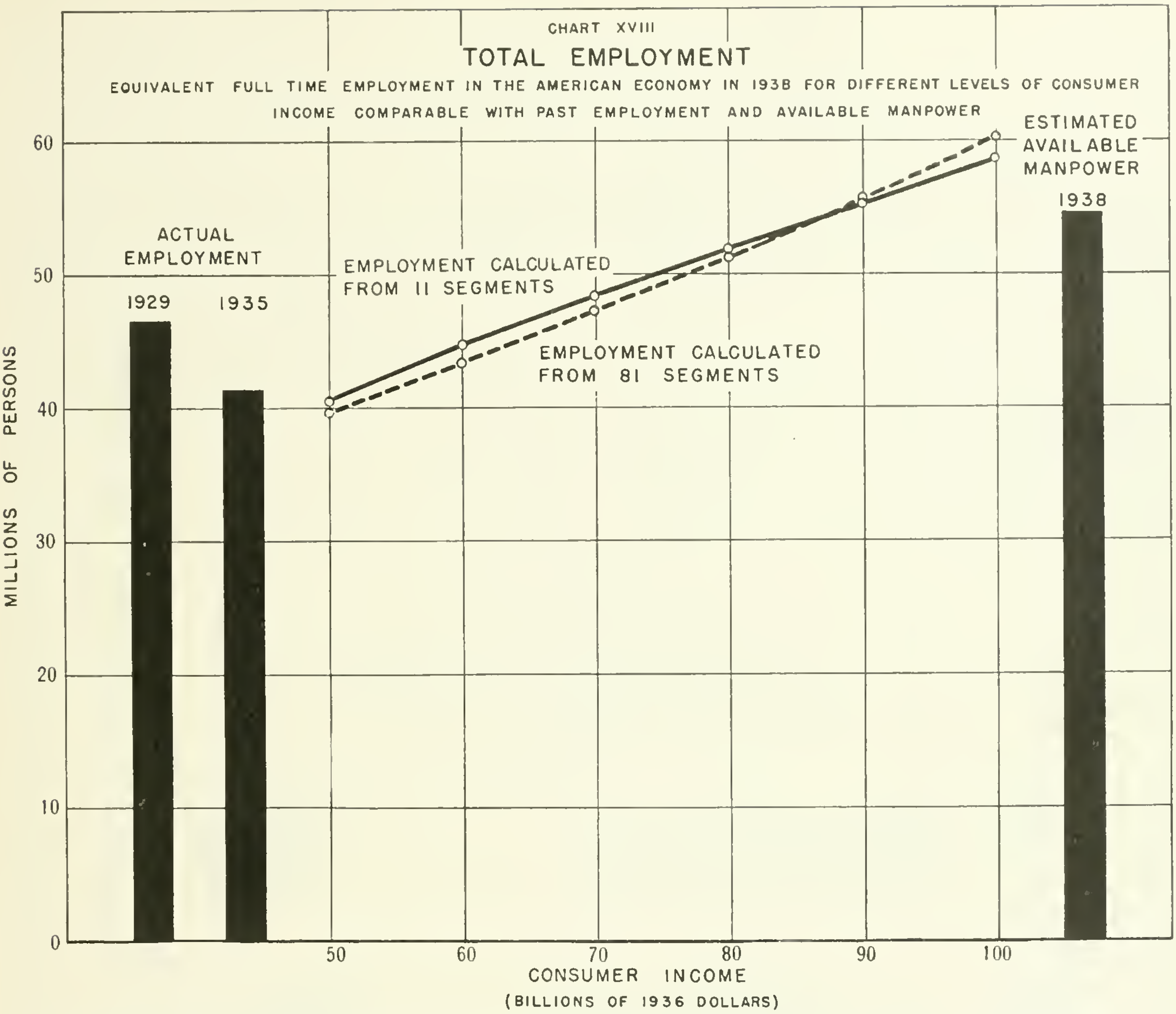

CHART XVIII

TOTAL EMPLOYMENT

EQUIVALENT FULL TIME EMPLOYMENT IN THE AMERICAN ECONOMY IN 1938 FOR DIFFERENT LEVELS OF CONSUMER INCOME COMPARABLE WITH PAST EMPLOYMENT AND AVAILABLE MANPOWER

Actually, however, the higher levels of buying power would call for more manpower than appears to be available. The National Research Project of the Works Progress Administration has made estimates of available manpower in previous years and, adjusting these for population growth, it is possible to give a very rough estimate of the manpower that is likely to be available for employment. This comes to approximately 54.5 million persons in 1938.[8]

However, it is unlikely that all of the available manpower could be employed at any one time. Some persons are likely to be shifting from one job to another, seasonal factors intervene, temporary unemployment may develop in one area at the very time that additional workers are needed elsewhere. Thus, some unemployment is likely to persist.

No effort has been made in this report to make an estimate of the minimum unemployment that is likely to arise. Any precise statement of the national income which would involve practically full employment must take this minimum unemployment into account by deducting this amount of manpower from the available supply to obtain the practical available manpower. Since the estimate of available manpower given above is far from reliable and since there is much disagreement as to the magnitude of the minimum necessary unemployment, the procedure adopted in this report will be to discuss the level of national income which

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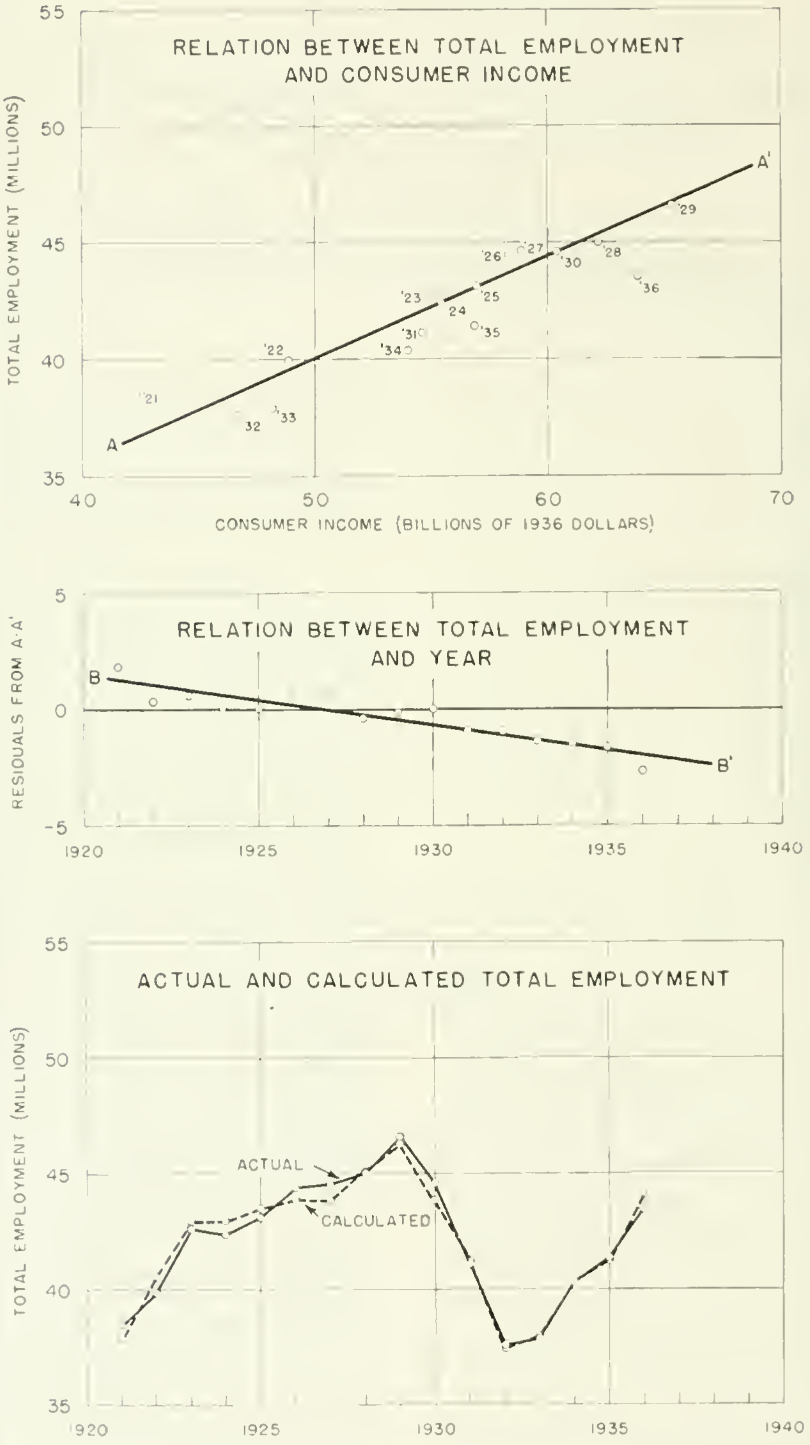
[8] No effort is here being made to make a careful estimate of total manpower available. The current census of unemployment should make possible a more accurate estimate. In making a more precise estimate, account should be taken of the minimum amount of unemployment which is inevitable as seasonal factors, shift in locus of employment, etc., make complete employment of manpower unlikely. See table I of Appendix 2.

CHART XIX

TOTAL EMPLOYMENT RELATED TO CONSUMER INCOME AND YEAR

1921–1936

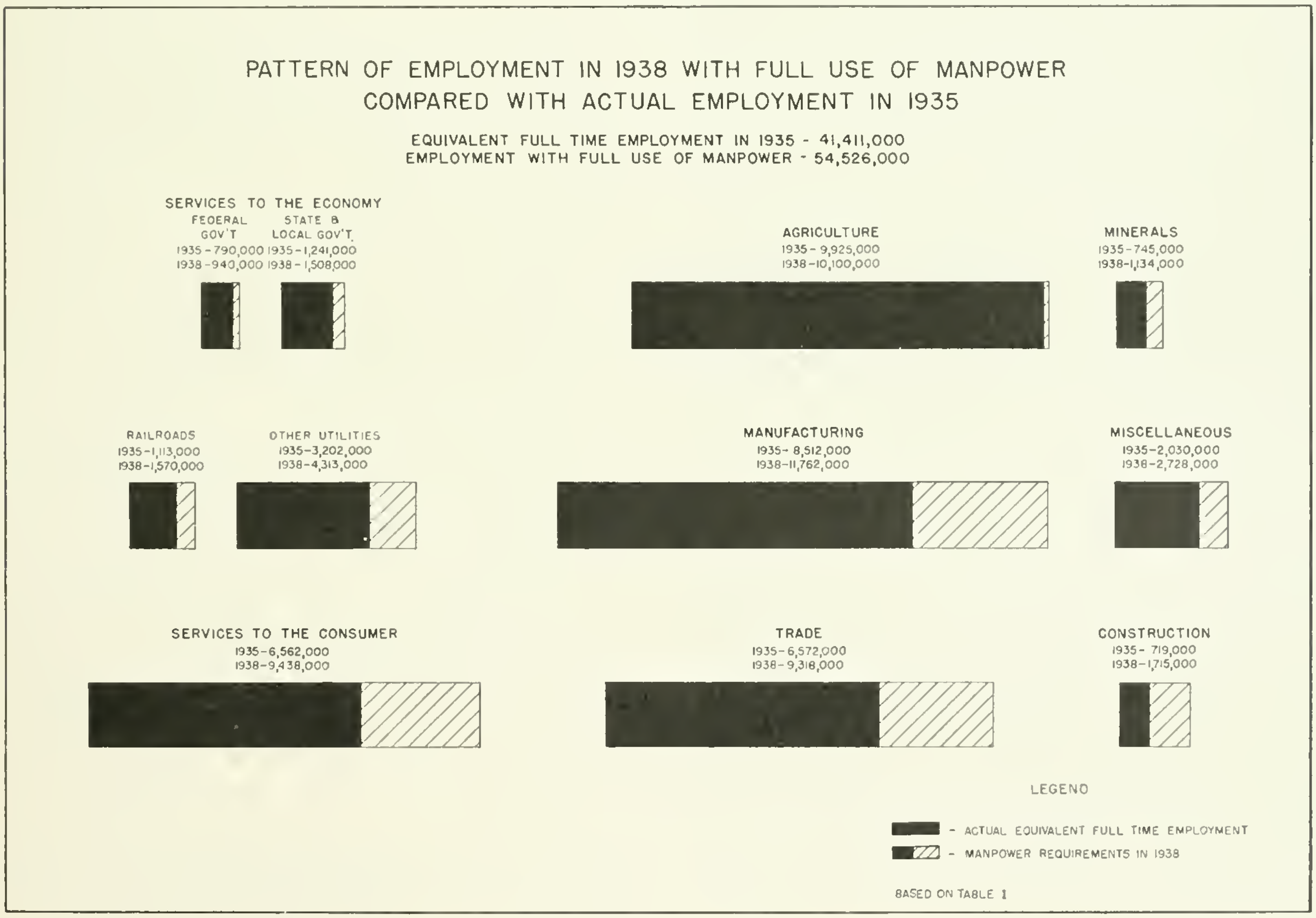


SOURCE: FOR TOTAL EMPLOYMENT AND CONSUMER INCOME SEE TABLE I OF THE APPENDIX would theoretically absorb all of the available manpower and indicate that the practical level must be somewhat below such a figure. As the uncertainties as to the available manpower and as to the magnitude of the inevitable unemployment are cleared up, a more precise estimate should be made of the consumer income corresponding to the economic activity which would absorb all of the practically available manpower.

With this caveat, it is appropriate to compare the estimated available manpower with the manpower called for at various levels of income. It would appear that the manpower available in 1938 would be fully absorbed at a level of activity corresponding to a consumer income of 88 billion dollars, when the latter is measured in terms of 1936 dollars. At such a level of buying power, the analyses indicate that unemployment would have disappeared. Such a level of buying power or consumer income would be an increase of 35 percent over the consumer income of 1929 and an increase of 30 percent over the estimated consumer income of 1937. If the level of buying power were stated in 1929 dollars, the consumer income at this level of activity would be 105 billion dollars as compared with the actual consumer income in 1929 of 79.3 billion dollars. It would correspond to the full use of available man-power. Practically full employment would presumably occur at a slightly lower figure.

The actual amount of money income which would constitute a real consumer buying power of 88 billion dollars when stated in 1936 dollars or of 105 billion dollars when stated in 1929 dollars would depend on the level of prices at which the income was received. Yet no reliable forecast of future prices can be made. It is likely that further increases in consumer income will be accompanied by some further increases in agricultural prices and in the prices of some other products, though this is by no means certain. If prices rose somewhat but did not return to the 1929 levels, the amount of consumer income corresponding to the activity absorbing all or practically all of the available manpower

CHART XX



would be likely to lie somewhere between 90 and 100 billion dollars when stated in current dollars.[9]

These figures of 88 billion dollars of consumer income (stated in 1936 dollars) or 90 to 100 billion dollars of national income (stated in dollars likely to be current) should be regarded as representing only a minimum goal toward which national policy might be oriented. It does not reflect the largest possible national income that could be developed. It only involves the carrying forward of activity exactly along the lines of recent development. It takes no account of the possibilities of accelerated use of improved techniques. It takes no account of the decreases in manpower requirements which could come from the improvement in the organization of resources. It takes no account of concealed unemployment represented by the groups of people like the southern mountaineers, the farmers on submarginal land, the population in abandoned coal regions who have been left in the eddies and backwashes of economic development and who are not effectively employed. How much greater the consumer income would be which would correspond with both full and efficient use of resources is a problem not being considered in this report. The techniques that have been developed here do not lend themselves to the calculation of the larger figure which would unquestionably arise. They are concerned only with the consumer income which would correspond to different levels of activity that might develop through the continuation of the trends underlying consumer expenditures and techniques of production. To see the possibility of increasing economic activity by as much as 30 percent without alteration either in the ways of doing business or in the conditions under which people spend their money is in itself to envisage an immediate goal well worth striving for.

It is one thing to have established with a fair degree of reliability the buying power which would correspond to a complete absorption of all of the available manpower—it is more important, however, to indicate the ways in which this manpower would be employed. How much would be employed in manufacture, how much in agriculture, how much in trade, how much in the service industries? What would be the pattern of employment at full use of available manpower? Such a pattern has been calculated and the results are presented in chart XX showing the employment likely to arise with a consumer income of 88 billion dollars. It is given for each of the main segments of economic activity, along with an indication of the employment in each of these segments in 1935. The relative increase in employment which would result in the different segments of the economy is indicated in each case by the cross-hatched area. In the case of most of the segments, the estimate is believed to be reasonably reliable. For the Federal Government, for agriculture, and for construction, only very crude guesses on employment can be made; but as has already been indicated, the role of the Federal Government in relation to the whole economy is small insofar as employment figures are concerned so that an error here has less significance, while in the case of agriculture, the variation from year to year is sufficiently small so that an unreliable estimate is not likely to introduce a significant error in the total picture. Construction alone stands as a major segment in which reliable estimates cannot be made and in which the volume of activity is sufficiently great as to make the error in this segment influence the whole picture significantly. This only repeats the conclusion often reached before on other grounds that either there is less underlying continuity in the construction industry than in most industries or that if such continuity exists, means have not yet been developed for measuring it. The latter may quite possibly be the case since the available data on construction activity are very far from adequate.

A more detailed breakdown of activity at full employment is given in table III which shows both consumption and employment for the 81 segments. The estimates for the bulk of the individual segments are not nearly as reliable as the estimate of full employment for the whole economy. The more reliable estimates are given in italic type and the less reliable are given in roman The former give a fairly reliable statement of the activity likely to occur at full employment, while the latter are most of them sufficiently reliable to give a rough indication of the magnitude of activity in the segments concerned.[10]

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[9] These figures are not directly comparable with the estimates made by Brookings Institution, *America's Capacity to Produce*, 1934, and by the New York Housing Authority, *Report of the National Survey of Potential Product Capacity*, 1936. These two studies introduce a shifting of workers from submarginal land and from retail distribution to other parts of the economy, thereby assuming a greater increase in efficiency in those two segments than past trends would indicate as likely to occur unless some radical innovations are introduced. The Brookings study makes no attempt to articulate increased consumption with increased production so that the greater expansion required for some industries and a less expansion for others is not adjusted for. The National Survey articulates consumption (not the most likely consumption but a prescribed standard and budget of living) with production but does not appear to have articulated employment and production. The present study assumes no radical innovations but does try to articulate consumption, production, and employment. The different aims of measurement and the different assumptions made in the three studies make it impossible to use their findings as a direct cross check on each other. Each study has its contribution to make to this new frontier of investigation.

[10] It should be recognized that the figures for employment in most of the separate segments involve somewhat greater likelihood of error than is involved in the separate employment analyses alone since an error in calculating employment for a given production may be added to or may be counterbalanced by an error in estimating consumption.

TABLE III.—*Patterns of resource use corresponding to a consumer income of 88 billion dollars* [1]

Code No.	Segment	Consumption		Employment (equivalent full time)
	SERVICES TO THE ECONOMY			
1	Federal Government			940,000
2	State and local government			*1,508,000*
3	Banking and finance			1,316,000
4	Post office	*722*	Deflated revenue, millions of 1929 dollars	*282,000*
5	Telephone	*233*	Index of connections, 1920=100	*382,000*
6	Telegraph	281.4	Millions of equated messages	*118,000*
7	Electric power and light	*145.5*	Billions of kilowatt-hours	*324,000*
8	Manufactured gas			*70,000*
9	Railroad transportation			*1,613,000*
9b	Passenger traffic, class I railways	*29.2*	Billions of revenue passenger-miles	
9c	Freight traffic, class I railways	*571*	Billions of net ton-miles	
10	Auto transportation			*1,036,000*
11	Transportation other than auto and railroad			*553,000*
	MANUFACTURING			
101	Butter, cheese, condensed milk, and ice cream	*123.3*	Index of deflated value, 1929=100	59,000
102	Meat packing	*1,191*	Millions of pounds, monthly average	152,000
103	Flour milling	*86.3*	Index of deflated value, 1929=100	25,000
104	Canning and preserving	6,539	Millions of pounds	148,000
105	Tobacco, manufacturing	*196*	Index, 1923–25=100	*88,000*
106	Sugar, extracting and refining	*6.8*	Millions of gross tons	26,000
107	Leather, tanned, curried, and finished	508	Deflated value, millions of 1929 dollars	*55,000*
108	Bread and other bakery products	*127.6*	Index of deflated value, 1929=100	*301,000*
109	Other foods			310,000
110	Confectionery and chocolate	*136.0*	Index of deflated value, 1929=100	*59,000*
111	Boots and shoes	*914*	Deflated value, millions of 1926 dollars	*226,000*
112	Leather products, other than leather and boots and shoes	571	Deflated value, millions of 1926 dollars	*78,000*
113	Woolen and worsted goods	106.7	Index of deflated value, 1929−100	161,000
114	Cotton textiles	144	Index of consumption of raw cotton, 1923–25=100	*595,000*
115	Silk and rayon goods	*270.2*	Index of deflated value, 1929=100	159,000
116	Rayon	372	Millions of pounds	45,000
118	Knit goods	170.4	Index of deflated value, 1929=100	251,000
119	Wearing apparel	5,430	Deflated value, millions of 1926 dollars	802,000
120	Dyeing and finishing			*115,000*
120.1	Other textiles	2,206	Deflated value, millions of 1926 dollars	*233,000*
121	Paper and pulp	*2,013*	10.000 net tons	*176,000*
122	Lumber and millwork	*360*	Millions of board feet	*492,000*
123	Paper products	1,297	Deflated value, millions of 1926 dollars	*138,000*
124	Furniture and related products	1,560	Deflated value, millions of 1926 dollars	333,000
125	Miscellaneous lumber products			*217,000*
126	Printing and publishing, newspaper and periodical	*156.4*	Index of deflated value, 1929=100	*158,000*
126.1	Printing and publishing, book, music, and job	1,216	Deflated value, millions of 1936 dollars	*212,000*
126.2	Printing and publishing, allied industries			*94,000*
127	Rubber tires and tubes	794	Millions of weighted aggregates of tires and tubes	72,000
128	Rubber products, other than tires and tubes	*417*	Deflated value, millions of 1926 dollars	*122,000*
129	Chemicals	*172.6*	Index of deflated value, 1929=100	*260,000*
129.1	Paints and varnishes	155.0	Index of deflated value, 1929=100	*43,000*
131	Petroleum refining	1,528	Millions of barrels	94,000
131c	Gasoline	*802*	Millions of barrels	
132	Glass	438	Deflated value, millions of 1926 dollars	66,000
133	Cement	*215.2*	Millions of barrels	*41,000*
134	Clay products, other than pottery	114.7	Index of deflated value, 1929=100	*102,000*
134.1	Pottery	156.5	Deflated value, millions of 1926 dollars	*48,000*
134.2	Marble, granite, and stone, and glass products, n. e. c			142,000
135	Fertilizer	71.0	Millions of tons	17,000
136	Coke	*80.6*	Millions of net tons	*32,000*
137	Iron and steel	*83.2*	Millions of gross tons	*607,000*
138	Nonferrous metals, other than copper smelting and refining			25,000
138b	Lead	*1,215*	Thousands of tons	
138c	Zinc	1,092	Thousands of tons	
138d	Nonferrous metals, other than copper, lead, and zinc	314.9	Weighted index, 1926=100	
138.1	Copper, smelting and refining	1,508	Thousands of net tons	13,000
139	Iron and steel products	5,360	Deflated value, millions of 1926 dollars	*729,000*
140	Nonferrous metal products			542,000
141	Automobiles			635,000
141b	Passenger car sales	6,878	Thousands	
141c	Commercial car sales	1,799	Thousands	
143	Transportation equipment, other than automobiles			165,000
144	Electrical machinery			445,000
145	Machinery, excluding electrical	7,706	Deflated value, millions of 1926 dollars	1,100,000
146	Miscellaneous manufacturing industries			*374,000*
	MINERALS			
201	Crude petroleum and natural gas	30.5	Thousands of wells drilled (output)	157,000
202	Bituminous coal	*558*	Millions of net tons	*491,000*
203	Anthracite coal	*83.7*	Millions of net tons	*153,000*
204	Other nonmetallic mining	*166.8*	Index, 1929=100	89,000
205	Metallic ore (metal mining)			170,000
205b	Iron ore	110.9	Millions of net tons	
206.1a	Nonferrous metallic ores	940	Millions of current dollars	
	BULK DISTRIBUTION AND CONSTRUCTION			
301	Wholesale trade			*1,834,000*
302	Business service			416,000
401	Retail trade			*6,894,000*
500	Construction	10.83	Deflated value, billions of 1929 dollars	1,715,000
	SERVICES TO THE CONSUMER			
601	Public education			*1,245,000*
602	Private education			*232,000*
603	Professional service			1,477,000
604	Personal service			*2,239,000*
605	Domestic service			*2,504,000*
606	Recreation and amusement			*341,000*
607	Miscellaneous consumers' services			*478,000*
	MISCELLANEOUS			
800	Miscellaneous industries			*2,728,000*
801	Non wage earners in mining and manufacturing			1,953,000
900	Agriculture			10,100,000
	Employment all segments			54,688,000
	Estimated available manpower in 1938 [2]			54,500,000

[1] Obtained from the 80 and 90 consumer income columns of table II by linear interpolation.

[2] See table I of Appendix 2.

NOTE.—The estimates shown are not all of equal reliability; see charts XXI–LVI for the group letter indicating the degree of reliability of each analysis. The numbers in italic type indicate the figures which are based on analyses which are considered reliable.

The activity that could be expected with a consumer income of 88 billion dollars has been examined in detail because it would involve a complete elimination of unemployment. Yet even if a leeway had been allowed for the minimum inevitable unemployment, there is little likelihood that such a level could be reached in the immediate future. In many industries there is insufficient capital equipment to meet such a level of activity. In some directions there must be an insufficient supply of trained technicians or skilled operatives. The high level of production could not be suddenly attained from the present levels without a considerable degree of dislocation. Some level of activity intermediate between the present levels and full use of manpower would have more immediate significance. For this reason, a pattern of resource use corresponding to a consumer income of 75 billion dollars (stated in 1936 dollars) is set forth in the detail of 81 segments in table IV.

Because a consumer income of 75 billion dollars is closer to past experience than one of 88 billion, the estimates of activity for the individual segments are likely to be somewhat more reliable.[11] Undoubtedly, the picture could be made more precise and reliable through intensive work on the part of individuals concerned with particular industrial segments. In its present form, this pattern gives in crude outline the picture of activity which might be expected, with a consumer income of 75 billion dollars.

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[11] The errors resulting from extrapolation beyond the existing data would presumably be reduced to an appreciable degree.

TABLE IV.—*Patterns of resource use corresponding to a consumer income of 75 billion dollars* [1]

Code No.	Segment	Consumption		Employment (equivalent full time)
	SERVICES TO THE ECONOMY			
1	Federal Government			940,000
2	State and local government			1,460,000
3	Banking and finance			1,250,000
4	Post office	672	Deflated revenue, millions of 1929 dollars	282,000
5	Telephone	216	Index of connections, 1920=100	366,000
6	Telegraph	244.4	Millions of equated messages	110,000
7	Electric power and light	135.1	Billions of kilowatt-hours	308,000
8	Manufactured gas			60,000
9	Railroad transportation			1,360,000
9b	Passenger traffic, class I railways	23.9	Billions of revenue passenger-miles	
9c	Freight traffic, class I railways	446	Billions of net ton-miles	
10	Auto transportation			978,000
11	Transportation other than auto and railroad			496,000
	MANUFACTURING			
101	Butter, cheese, condensed milk, and ice cream	114	Index of deflated value, 1929=100	56,000
102	Meat packing	1,092	Millions of pounds, monthly average	136,000
103	Flour milling	84.9	Index of deflated value, 1929=100	25,000
104	Canning and preserving	5,716	Millions of pounds	127,000
105	Tobacco, manufacturing	178	Index, 1923-25=100	80,000
106	Sugar, extracting and refining	6.3	Millions of gross tons	25,000
107	Leather, tanned, curried, and finished	420	Deflated value, millions of 1929 dollars	49,000
108	Bread and other bakery products	117.6	Index of deflated value, 1929=100	280,000
109	Other foods			259,000
110	Confectionery and chocolate	116.6	Index of deflated value, 1929=100	50,000
111	Boots and shoes	788	Deflated value, millions of 1926 dollars	208,000
112	Leather products, other than leather and boots and shoes	452	Deflated value, millions of 1926 dollars	66,000
113	Woolen and worsted goods	89	Index of deflated value, 1929=100	126,000
114	Cotton textiles	122	Index of consumption of raw cotton, 1923-25=100	414,000
115	Silk and rayon goods	221.3	Index of deflated value, 1929=100	140,000
116	Rayon	372	Millions of pounds	45,000
118	Knit goods	157.0	Index of deflated value, 1929=100	228,000
119	Wearing apparel	4,691	Deflated value, millions of 1926 dollars	690,000
120	Dyeing and finishing			100,000
120.1	Other textiles	1,790	Deflated value, millions of 1926 dollars	189,000
121	Paper and pulp	1,692	10,000 net tons	142,000
122	Lumber and millwork	258	Millions of board feet	361,000
123	Paper products	1,087	Deflated value, millions of 1926 dollars	120,000
124	Furniture and related products	1,141	Deflated value, millions of 1926 dollars	248,000
125	Miscellaneous lumber products			170,000
126	Printing and publishing, newspaper and periodical	137	Index of deflated value, 1929=100	143,000
126.1	Printing and publishing, book, music, and job	1,038	Deflated value, millions of 1936 dollars	176,000
126.2	Printing and publishing, allied industries			84,000
127	Rubber tires and tubes	672	Millions of weighted aggregates of tires and tubes	60,000
128	Rubber products, other than tires and tubes	345	Deflated value, millions of 1926 dollars	99,000
129	Chemicals	141.6	Index of deflated value, 1929=100	227,000
129.1	Paints and varnishes	123.0	Index of deflated value, 1929=100	35,000
131	Petroleum refining	1,336	Millions of barrels	88,000
131c	Gasoline	702	Millions of barrels	
132	Glass	368.3	Deflated value, millions of 1926 dollars	57,000
133	Cement	181.4	Millions of barrels	34,000
134	Clay products, other than pottery	78.4	Index of deflated value, 1929=100	70,000
134.1	Pottery	114.	Deflated value, millions of 1926 dollars	36,000
134.2	Marble, granite, and other glass products			92,000
135	Fertilizer	71	Millions of tons	17,000
136	Coke	54	Millions of net tons	26,000
137	Iron and steel	57.9	Millions of gross tons	456,000
138	Nonferrous metals, other than copper smelting and refining			23,000
138b	Lead	870	Thousands of tons	
138c	Zinc	748	Thousands of tons	
138d	Nonferrous metals, other than copper, lead, and zinc	224	Weighted index, 1926=100	
138.1	Copper, smelting and refining	916	Thousands of net tons	12,000
139	Iron and steel products	3,780	Millions of 1926 dollars	514,000

Obtained from the 70 and 80 consumer income columns of table II by linear interpolation.

TABLE IV.—*Patterns of resource use corresponding to a consumer income of 75 billion dollars*—Continued

Code No.	Segment	Consumption		Employment (equivalent full time)
	MANUFACTURING—continued			
140	Nonferrous metal products			376,000
141	Automobiles			457,000
141b	Passenger car sales	4,455	Thousands	
141c	Commercial car sales	1,113	Thousands	
143	Transportation equipment, other than automobiles			115,000
144	Electrical machinery			298,000
145	Machinery, excluding electrical	5,665	Deflated value, millions of 1926 dollars	808,000
146	Miscellaneous manufacturing industries			286,000
	MINERALS			
201	Crude petroleum and natural gas	27.2	Thousands of wells drilled (output)	141,000
202	Bituminous coal	462	Millions of net tons	422,000
203	Anthracite coal	76	Millions of net tons	132,000
204	Other nonmetallic mining	125	Index, 1929=100	66,000
205	Metallic ores (metal mining)			117,000
205b	Iron ore	71.7	Millions of net tons	
206.1a	Nonferrous metallic ores	566	Millions of current dollars	
	BULK DISTRIBUTION AND CONSTRUCTION			
301	Wholesale trade			1,675,000
302	Business service			372,000
401	Retail trade			6,080,000
500	Construction	8.55	Deflated value, billions of 1929 dollars	1,528,000
	SERVICES TO THE CONSUMER			
601	Public education			1,245,000
602	Private education			232,000
603	Professional service			1,454,000
604	Personal service			2,040,000
605	Domestic service			2,152,000
606	Recreation and amusement			292,000
607	Miscellaneous consumers' services			440,000
	MISCELLANEOUS			
800	Miscellaneous industries			2,448,000
801	Nonwage earners in mining and manufacturing			1,766,000
900	Agriculture			10,100,000
	Employment all segments			49,234,000
	Estimated available manpower in 1938 [2]			54,500,000

[2] Estimates from the data on labor force in table I of Appendix 2.

NOTE.—The estimates shown are not all of equal reliability; see charts XXI–LVI for the group letter indicating the degree of reliability of each analysis.

CONCLUSIONS

The conclusions reached in this report fall into two categories, the first group having to do with the general character of the economy and the possibility of constructing patterns of resource use, while the second has to do with the specific patterns of resource use derived.

The extensive presence of continuities underlying consumer expenditure and techniques of production appears to be conclusively established. The possibility of constructing patterns of resource use which indicate approximately the use of resources likely to arise under different conditions is also indicated. Just how precise and reliable and in how much detail such patterns can be made remains to be established through further experiment in this field.

The actual patterns of resource use developed in this report indicate that a full use of manpower and the elimination of unemployment would be reached at that level of activity at which consumer income when stated in 1936 dollars would be in the vicinity of 88 billion dollars. If the development of such a level of activity were to involve some increase in agricultural and similar prices but did not lift prices to the 1929 level, the money income received by consumers which would correspond with full employment would be likely to lie somewhere between 90 and 100 billion dollars.

Such a level of economic activity and consumer income represents a most desirable objective towards which to orient national policy. Yet such a level is not likely to be reached in a single year. For this reason, a pattern of resource use corresponding to a consumer income of 75 billion dollars is outlined. This is somewhat above recent levels, yet not so far above as to be unattainable in the near future.

CHART XXI

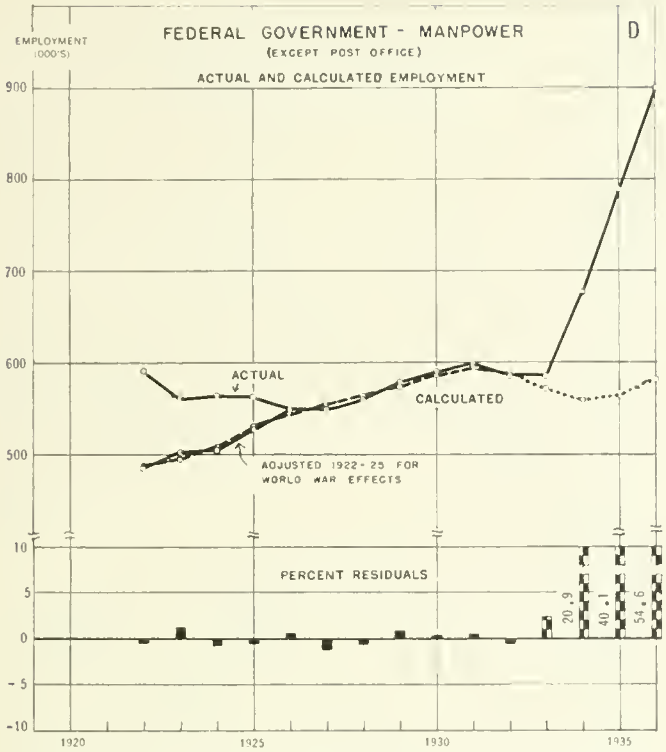

FIG 1a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 1a IN APPENDIX

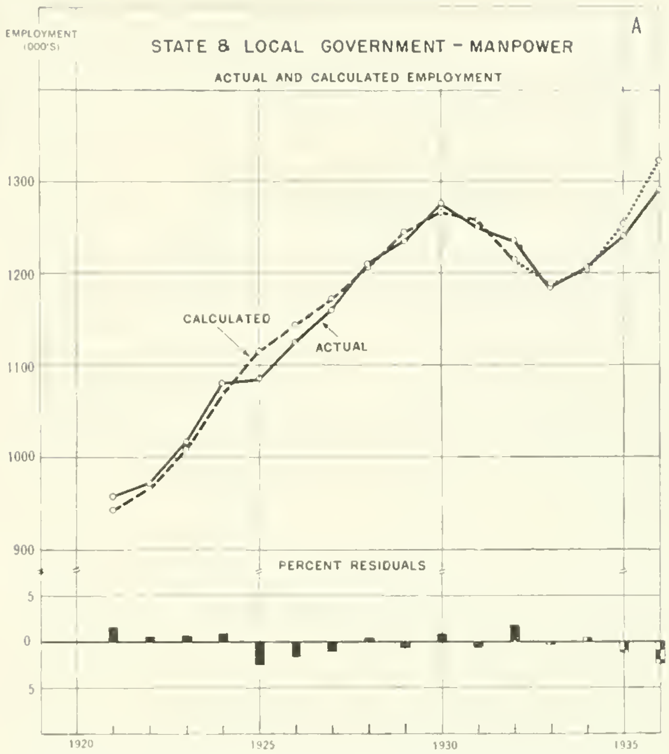

FIG 2a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 2a IN APPENDIX

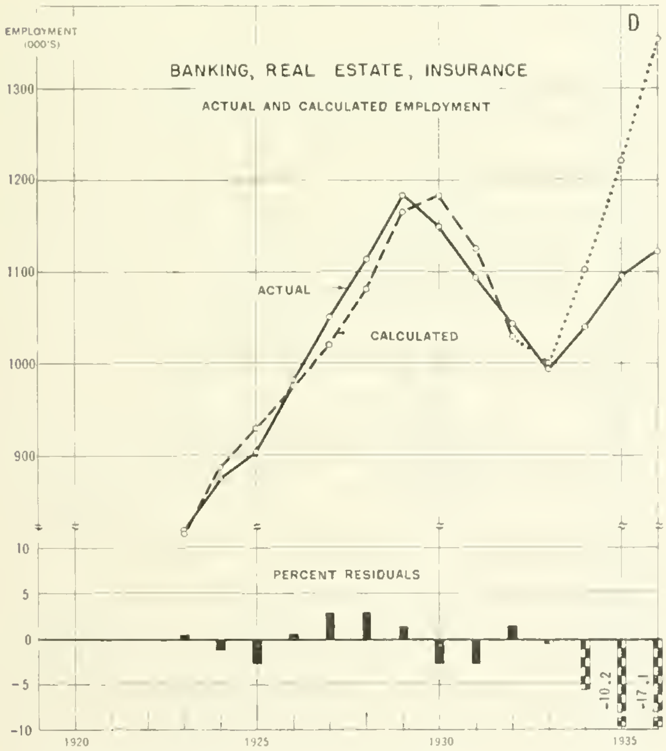

FIG 3a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 3a IN APPENDIX

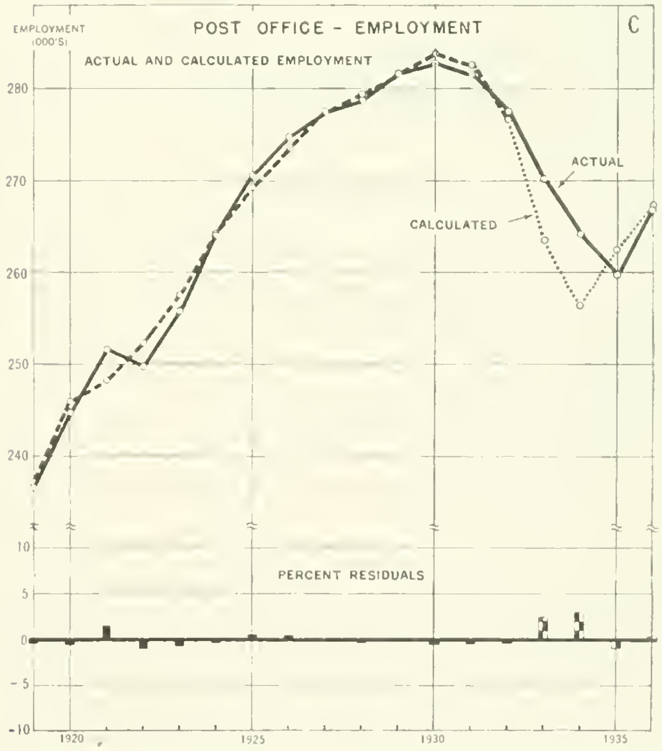

FIG 4a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO DEFLATED REVENUE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 4a IN APPENDIX

CHART XXII

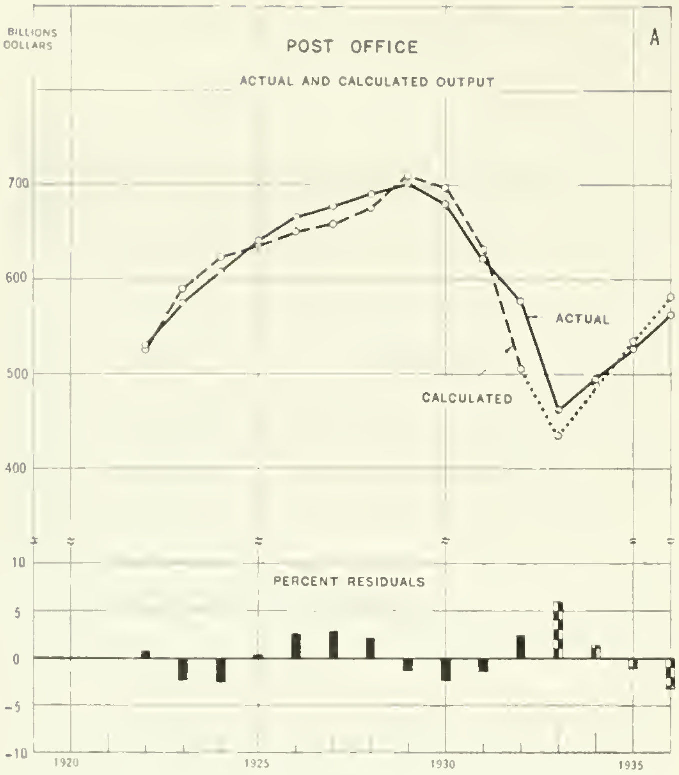

FIG. 4b CALCULATED OUTPUT IS BASED ON A FORMULA WHICH RELATES OUTPUT TO CONSUMER INCOME, DEFLATED INDEX OF POSTAL RATES AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 4b IN APPENDIX.

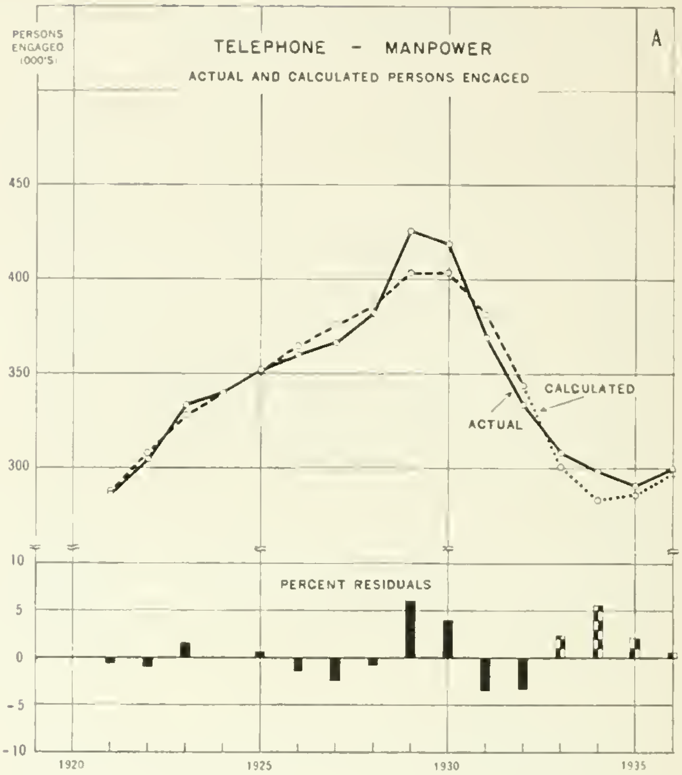

FIG. 5a CALCULATED PERSONS ENGAGED IS BASED ON A FORMULA WHICH RELATES MANPOWER TO OUTPUT AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 5a IN APPENDIX.

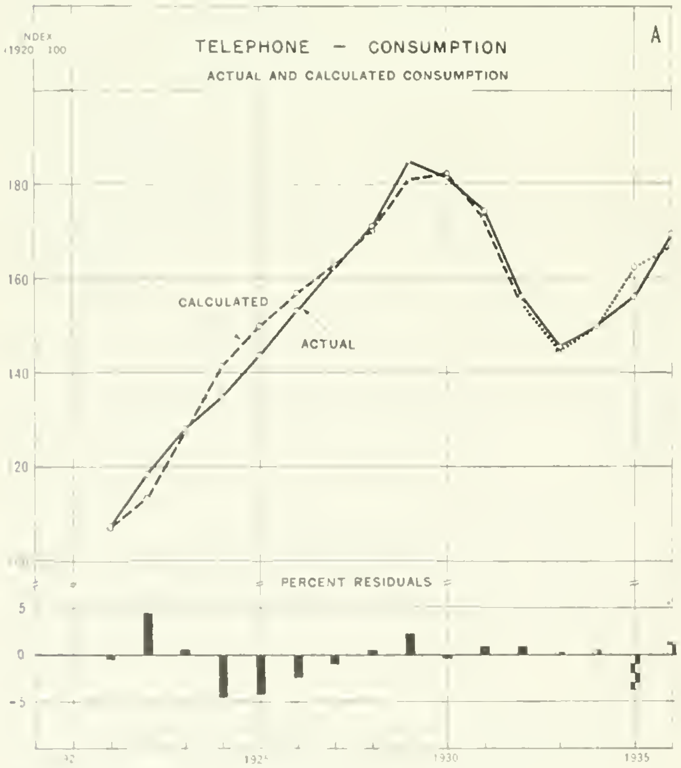

FIG. 5b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 5b IN APPENDIX.

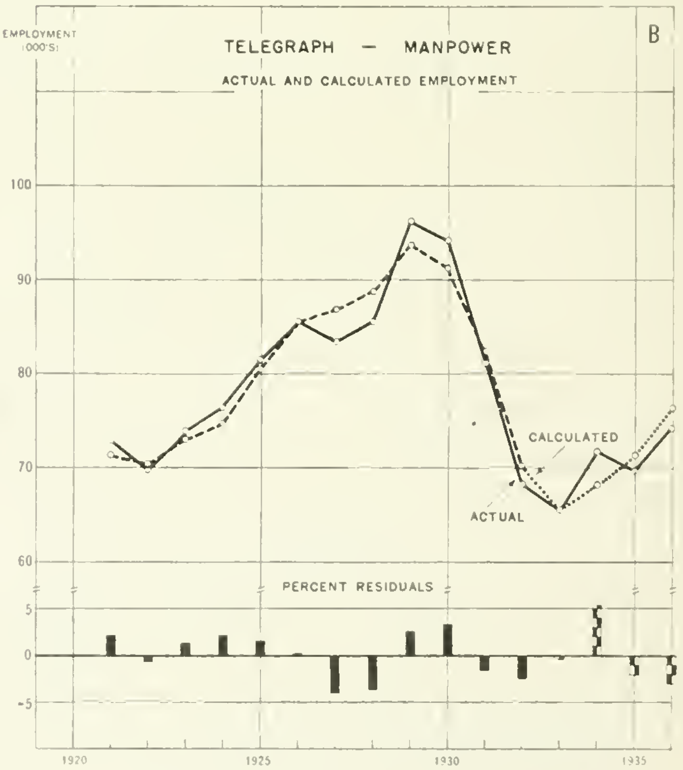

FIG. 6a CALCULATED MANPOWER IS BASED ON A FORMULA WHICH RELATES MANPOWER TO OPERATING REVENUE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 6a IN APPENDIX.

CHART XXIII

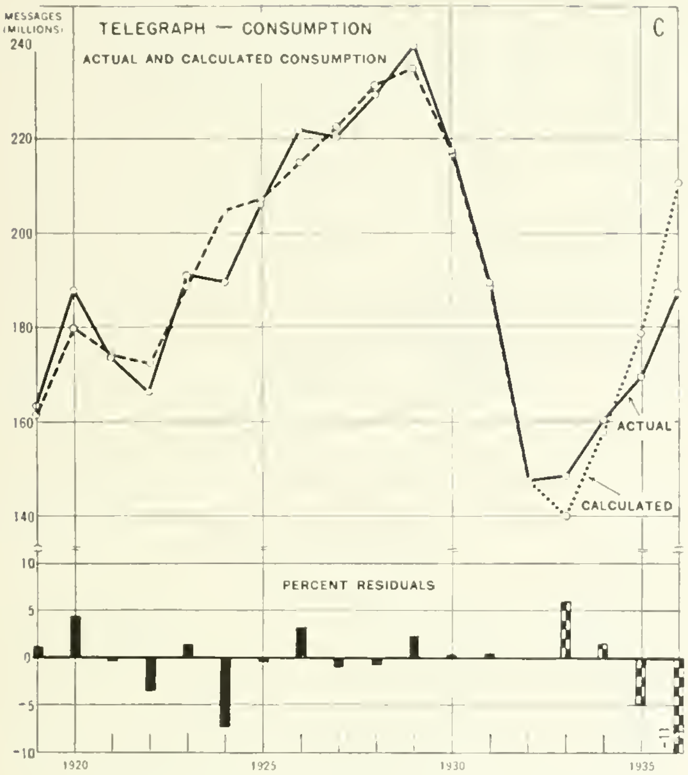

FIG 6b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES OUTPUT TO CONSUMER INCOME, REAL COST PER MESSAGE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 6b IN APPENDIX.

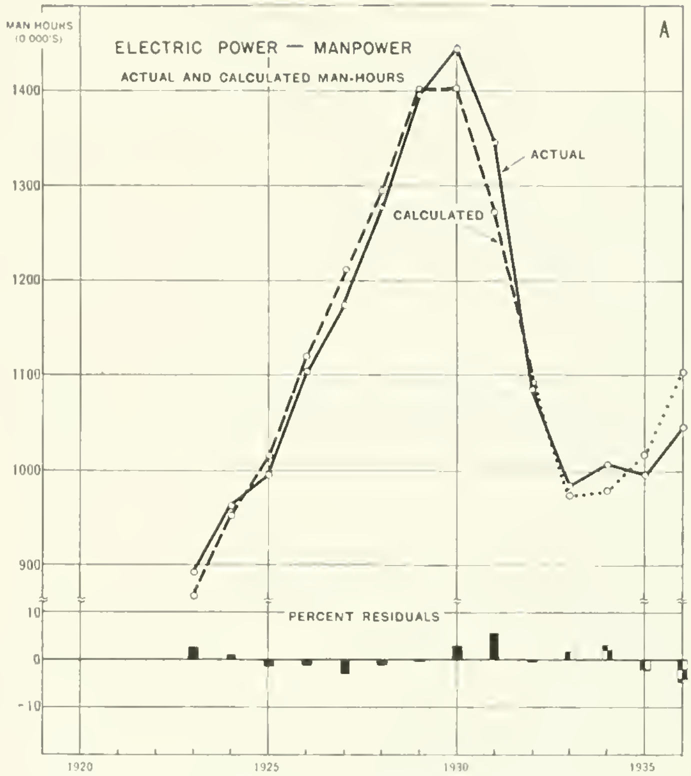

FIG 7a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO ELECTRIC POWER PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 7a IN APPENDIX

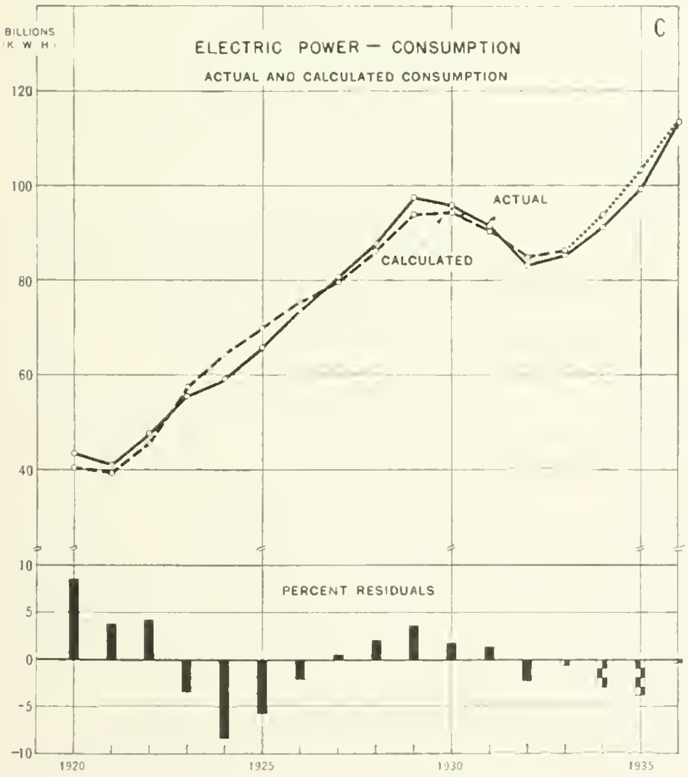

FIG 7b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES INDUSTRIAL PRODUCTION TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 7b IN APPENDIX

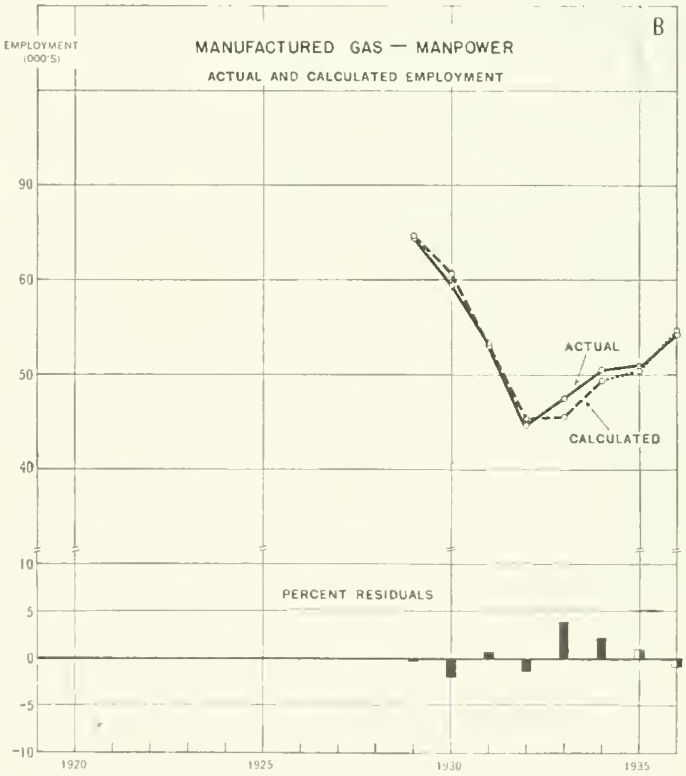

FIG 8a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 8a IN APPENDIX

CHART XXIV

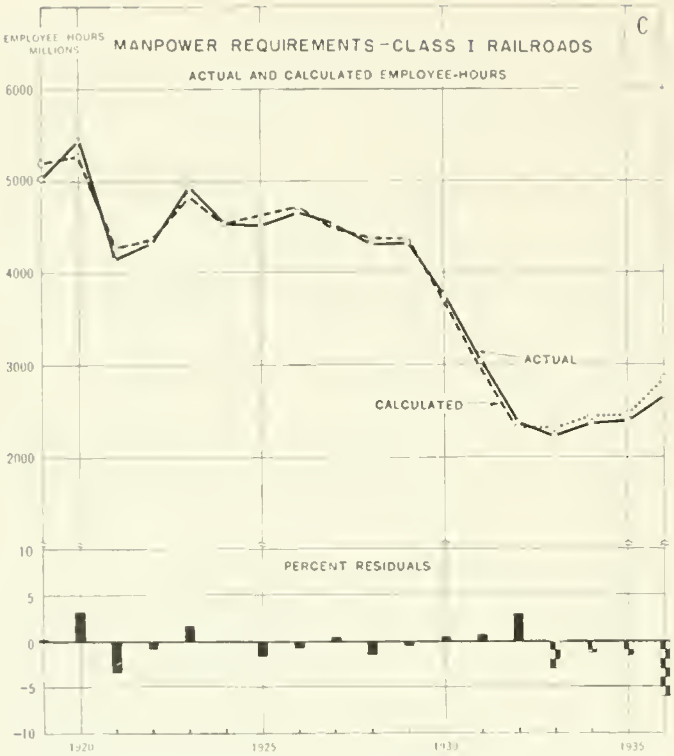

FIG 9a CALCULATED EMPLOYEE HOURS ARE BASED ON A FORMULA WHICH RELATES MANPOWER REQUIREMENTS TO NET TON MILES REVENUE AND NONREVENUE, REVENUE PASSENGER MILES AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 9a IN APPENDIX

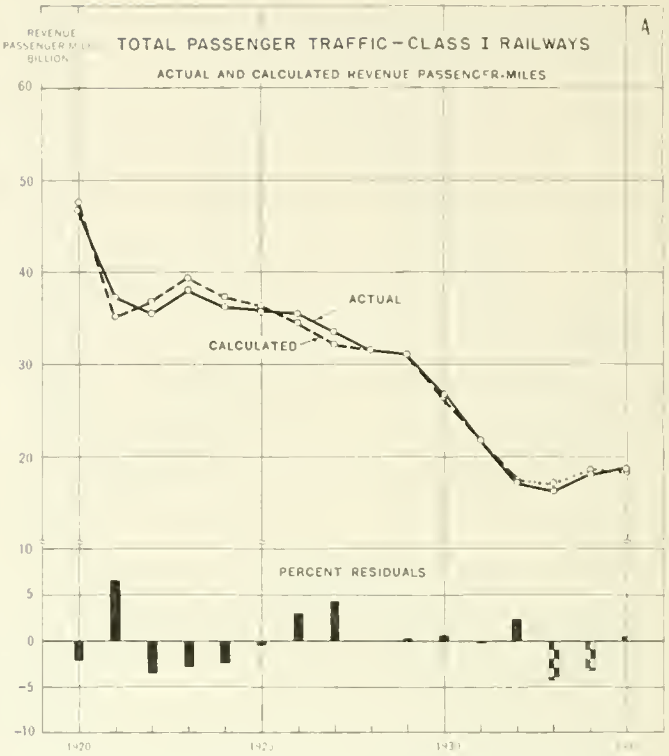

FIG 9b CALCULATED REAL PASSENGER MILES ARE BASED ON A FORMULA WHICH RELATES REVENUE PASSENGER MILES TO CONSUMER INCOME, PASSENGER RATES AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 9b IN APPENDIX

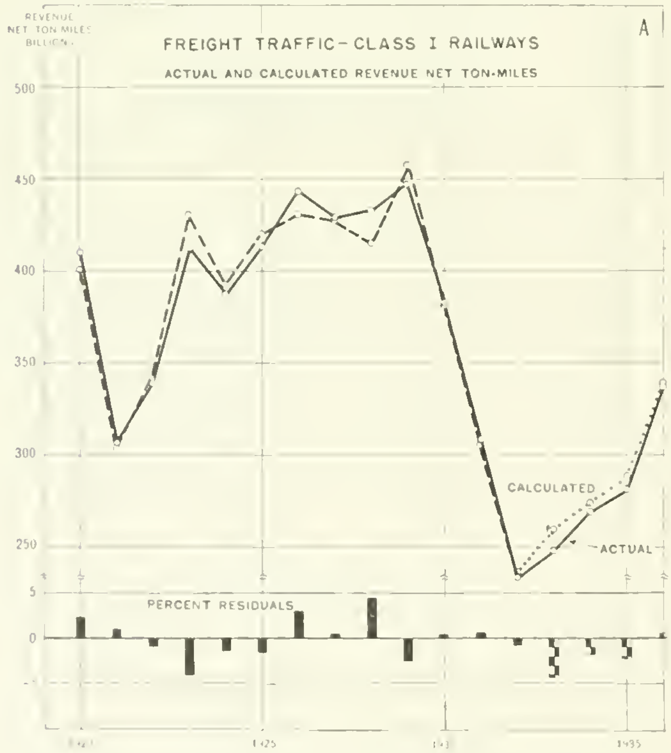

FIG 9c CALCULATED REVENUE NET TON MILES ARE BASED ON A FORMULA WHICH RELATES FREIGHT TO INDUSTRIAL PRODUCTION FOR THE YEAR ENDING SEPTEMBER AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 9c IN APPENDIX

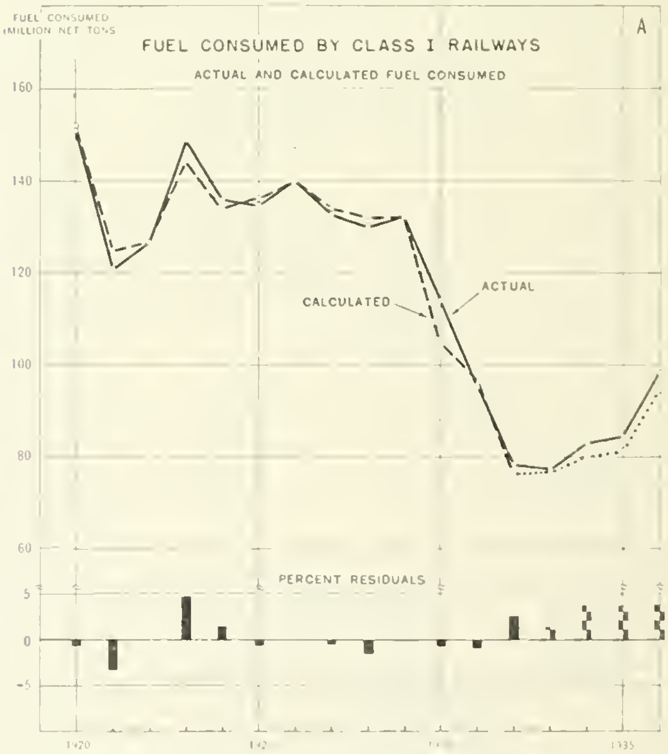

FIG 9d CALCULATED FUEL CONSUMED IS BASED ON A FORMULA WHICH RELATES FUEL CONSUMED TO NET TON MILES REVENUE AND NON REVENUE, REVENUE PASSENGER MILES AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 9d IN APPENDIX

CHART XXV

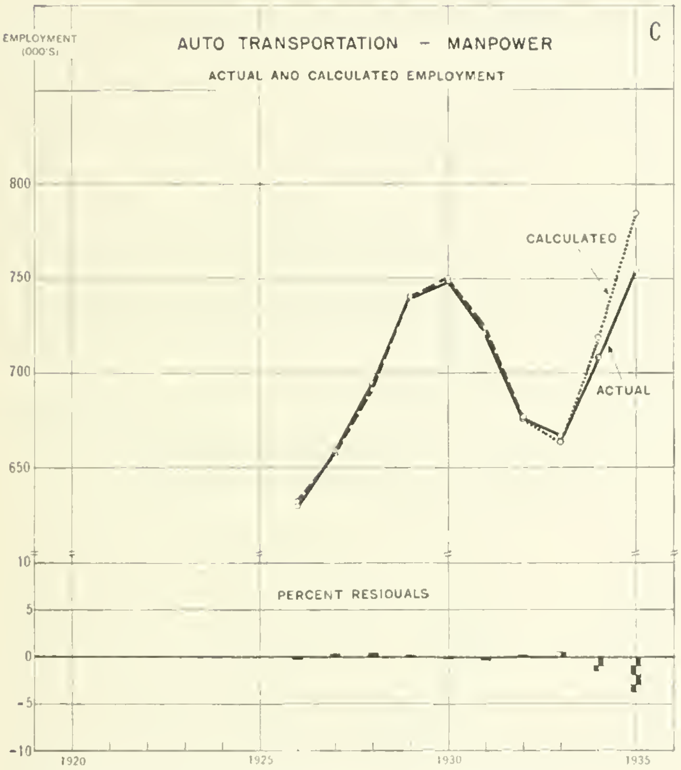

FIG. 10a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 10a IN APPENDIX.

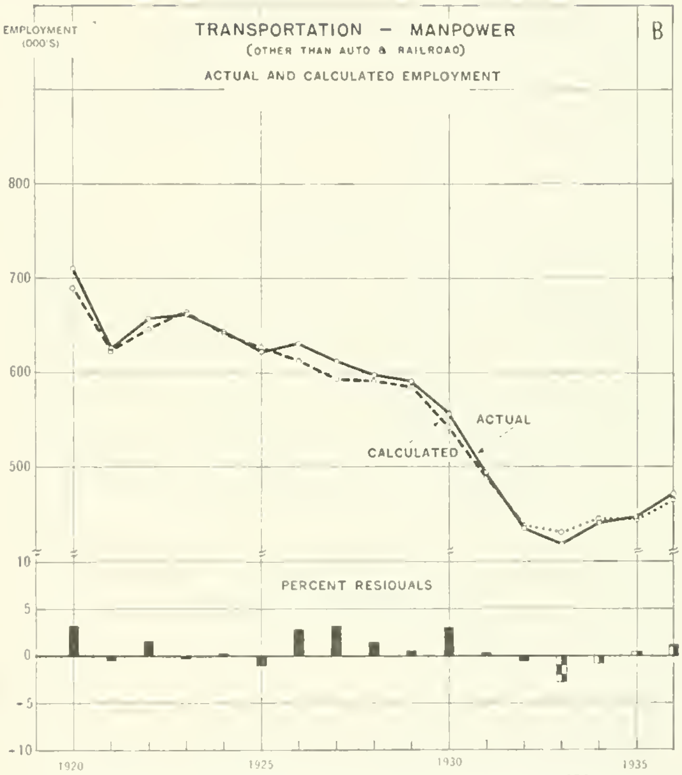

FIG. 11a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES TRANSPORTATION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 11a IN APPENDIX.

CHART XXVI

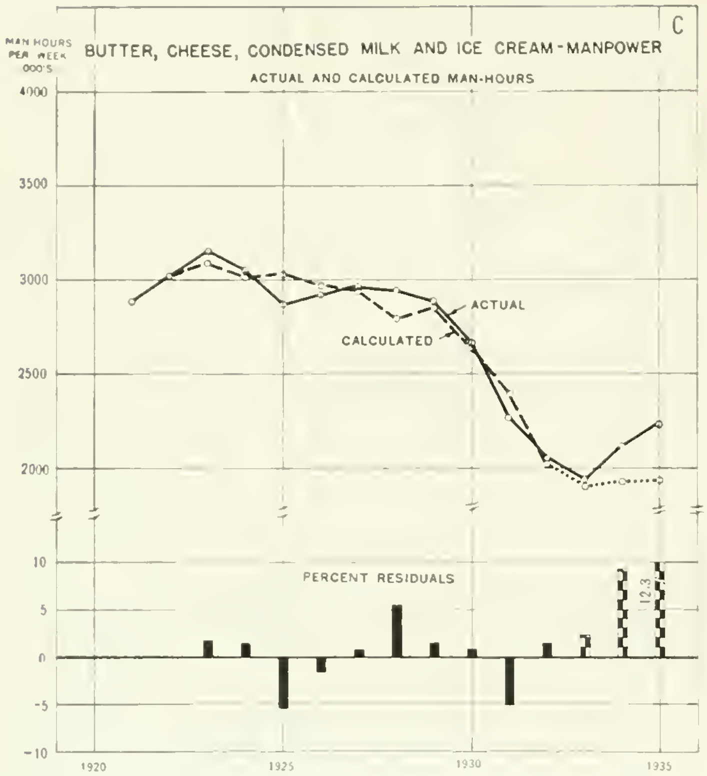

FIG 101a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 101a IN APPENDIX

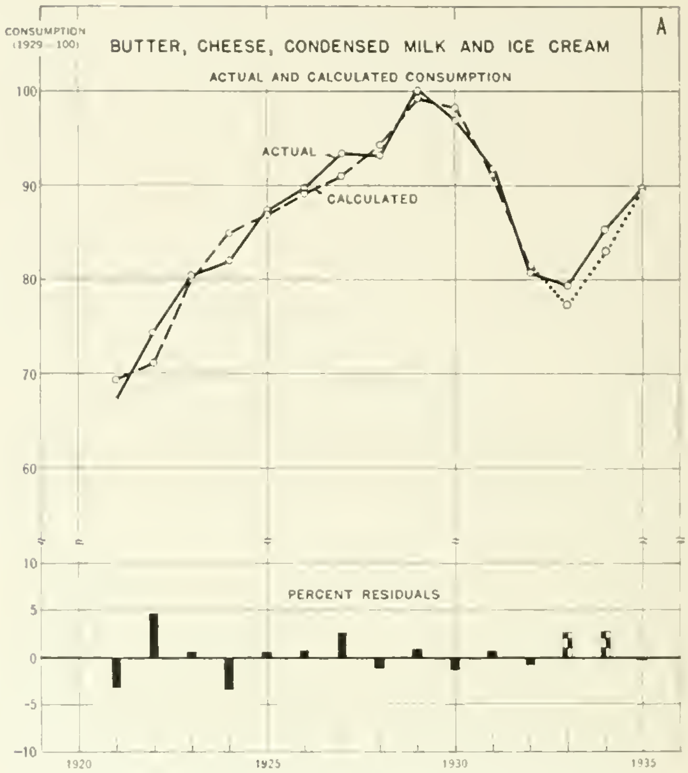

FIG 101b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 101b IN APPENDIX

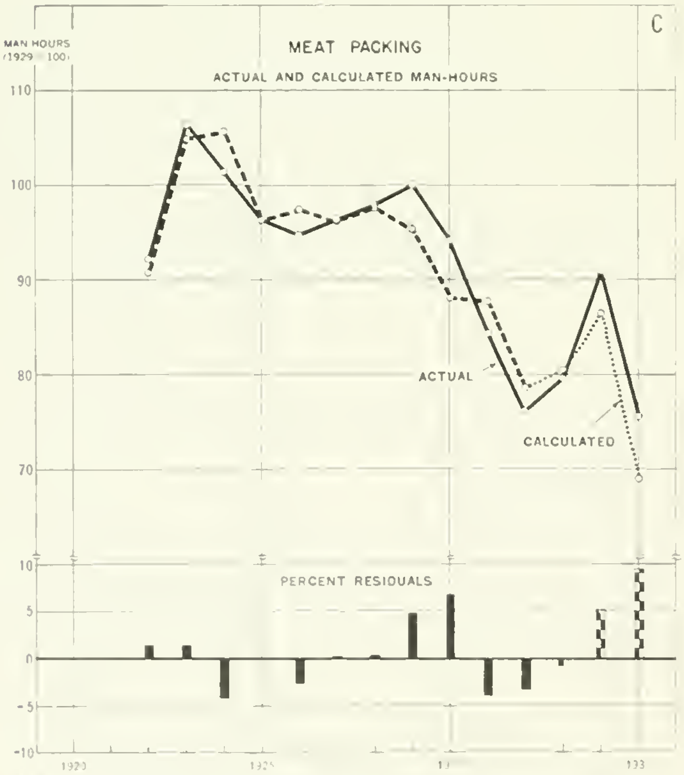

FIG 102a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MEAT PACKING MAN-HOURS TO PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 102a IN APPENDIX

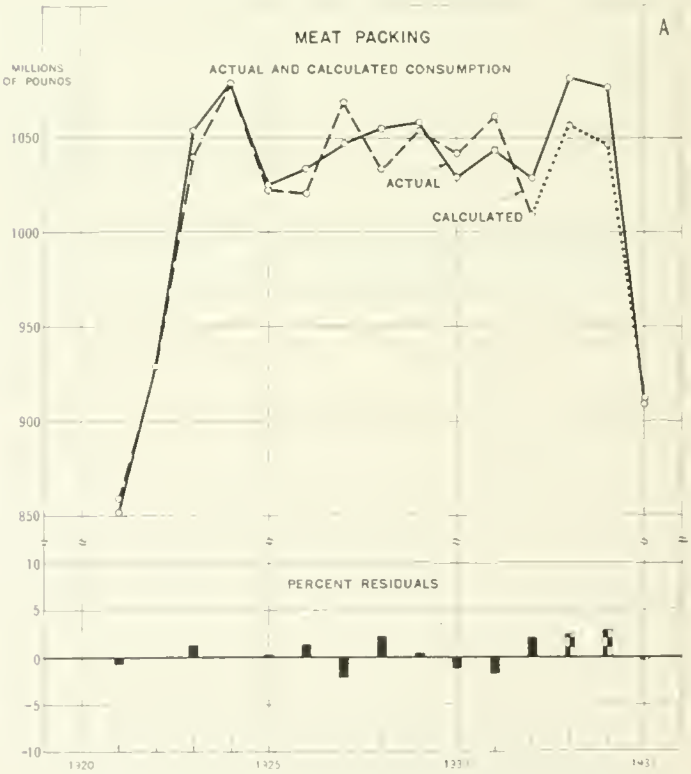

FIG 102b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO REAL NON-AGRICULTURAL INCOME, REAL PRICE OF MEAT AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO.102b IN APPENDIX

CHART XXVII

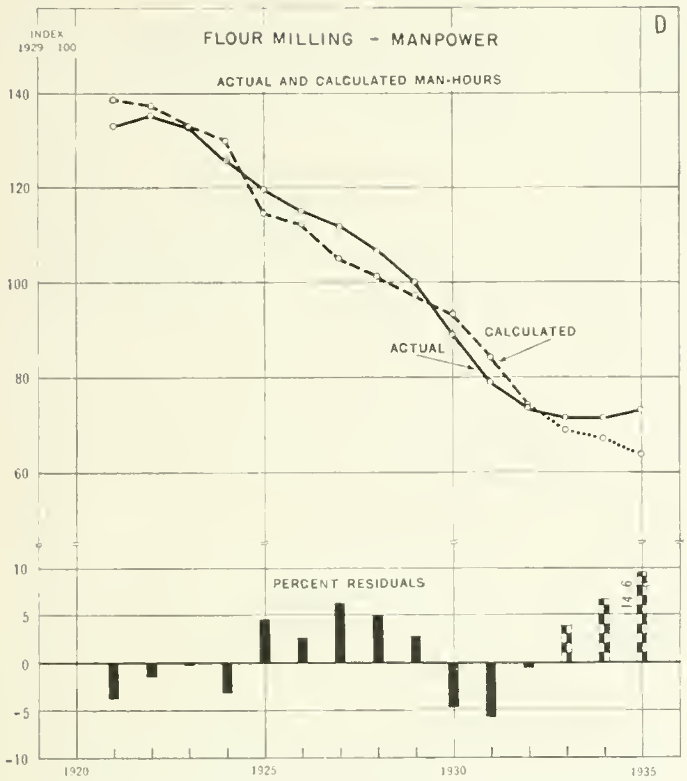

FIG. 103a CALCULATED MANPOWER IS BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 103a IN APPENDIX.

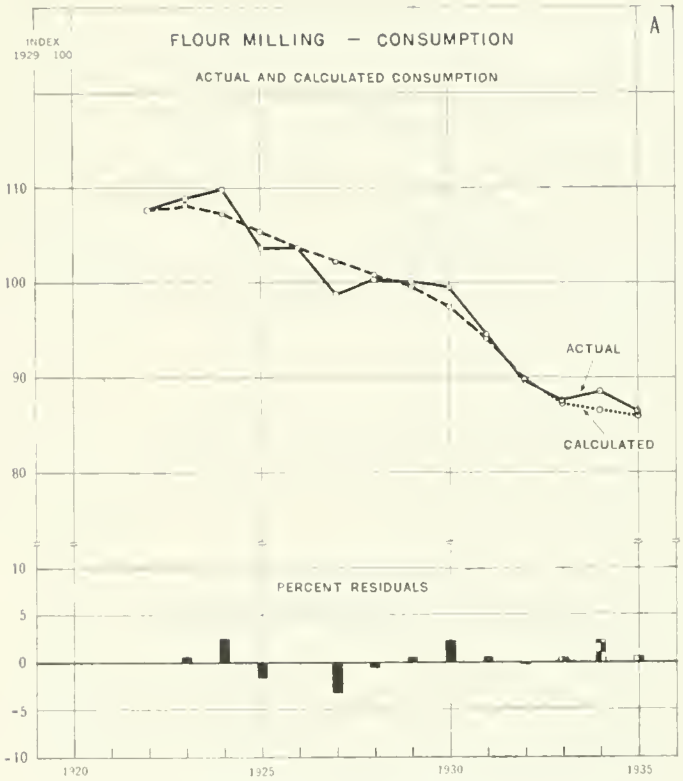

FIG. 103b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 103b IN APPENDIX.

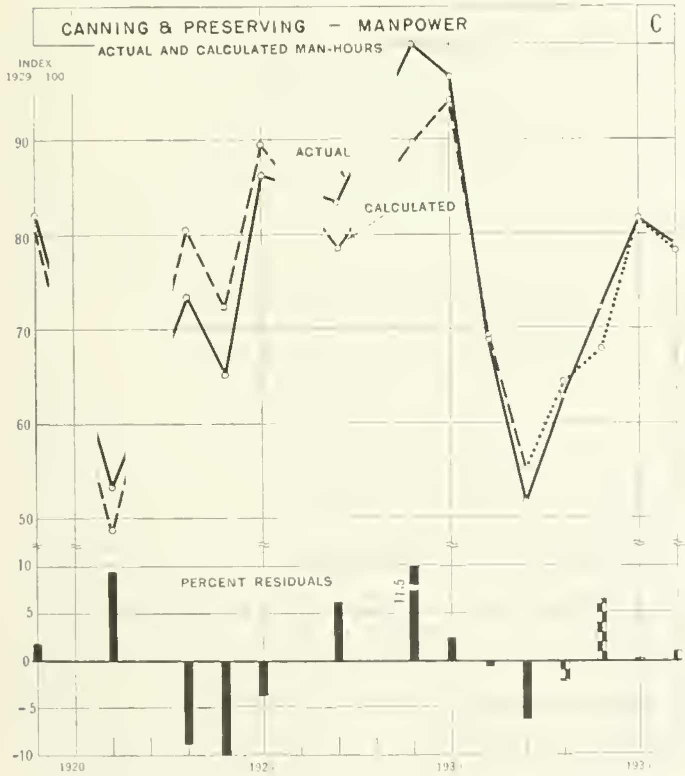

FIG. 104a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 104a IN APPENDIX.

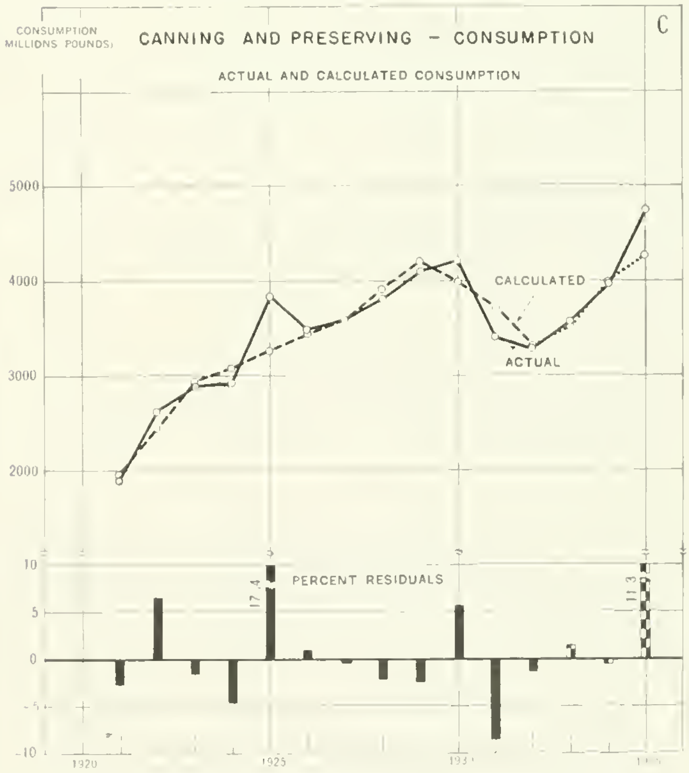

FIG. 104b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 104b IN APPENDIX.

CHART XXVIII

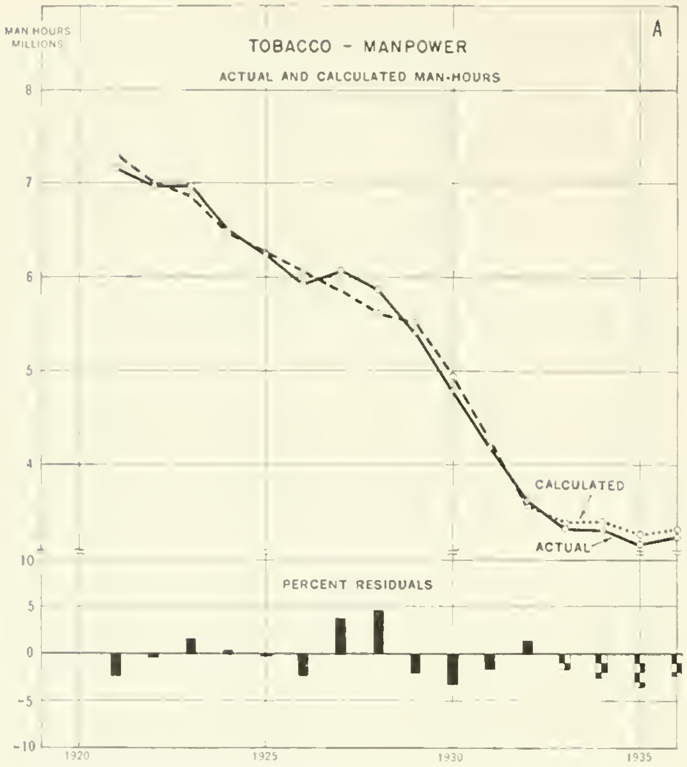

FIG 105a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO TOBACCO MANUFACTURE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 105a IN APPENDIX.

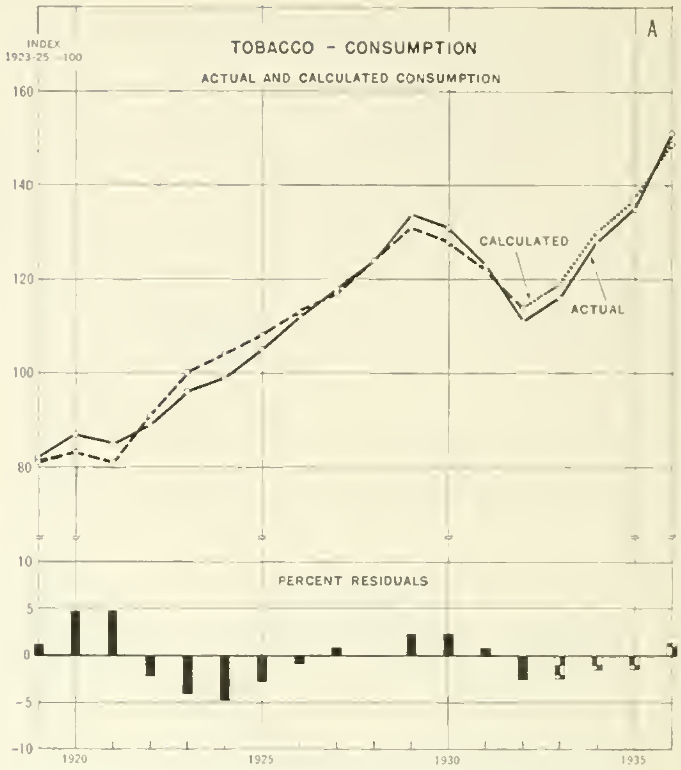

FIG. 105b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 105b IN APPENDIX

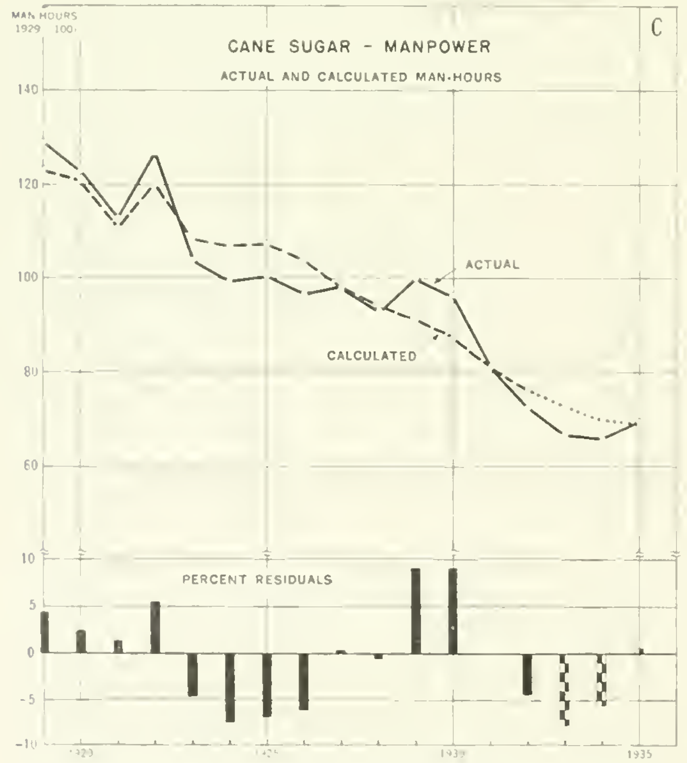

FIG 106a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN HOURS TO CANE SUGAR PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 106a IN APPENDIX

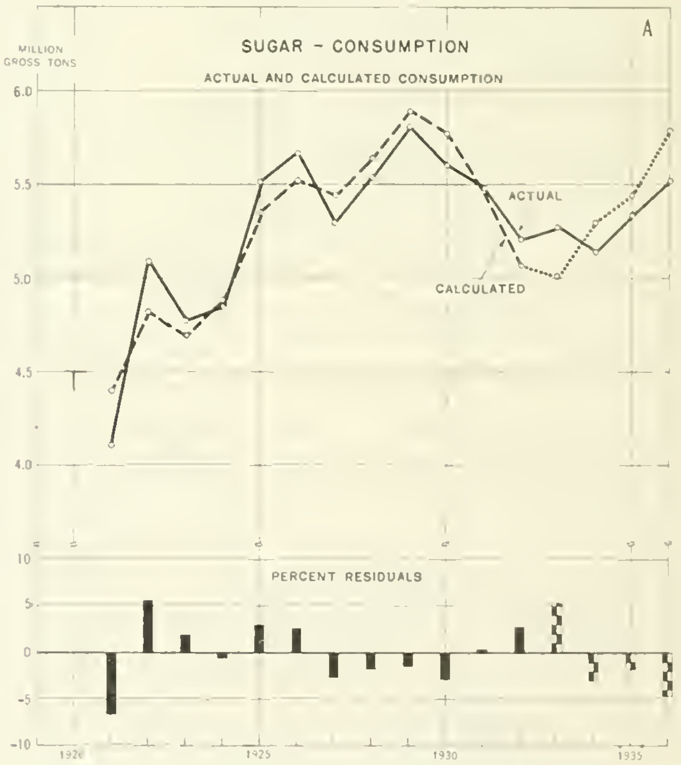

FIG. 106b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, REAL RETAIL PRICE, AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 106b IN APPENDIX

CHART XXIX

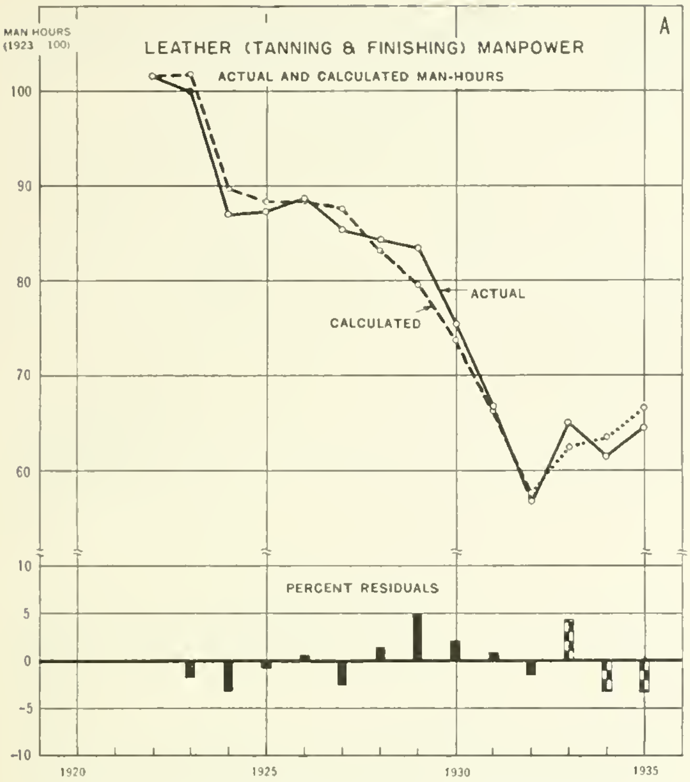

FIG. 107a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO LEATHER TANNING AND FINISHING AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 107a IN APPENDIX

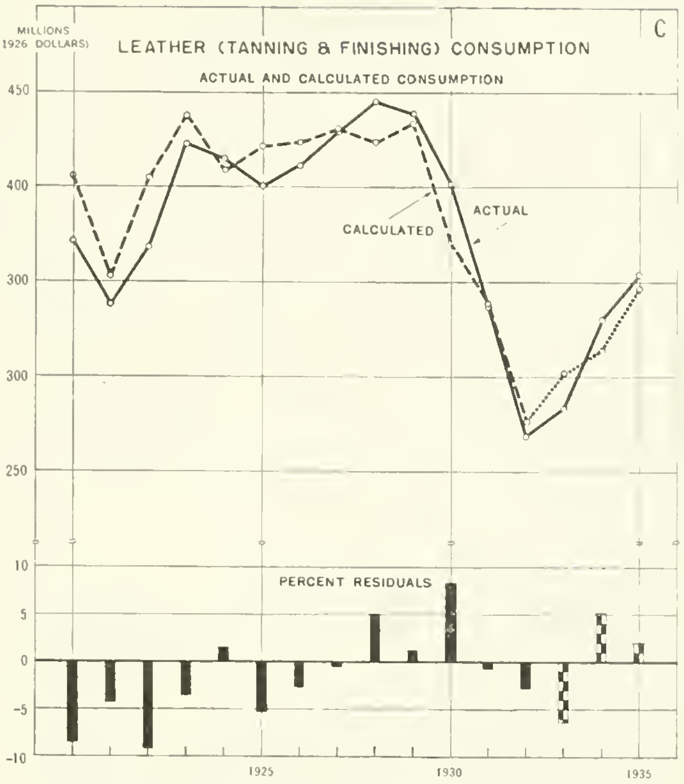

FIG 107b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO LEATHER DEMAND AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 107b IN APPENDIX

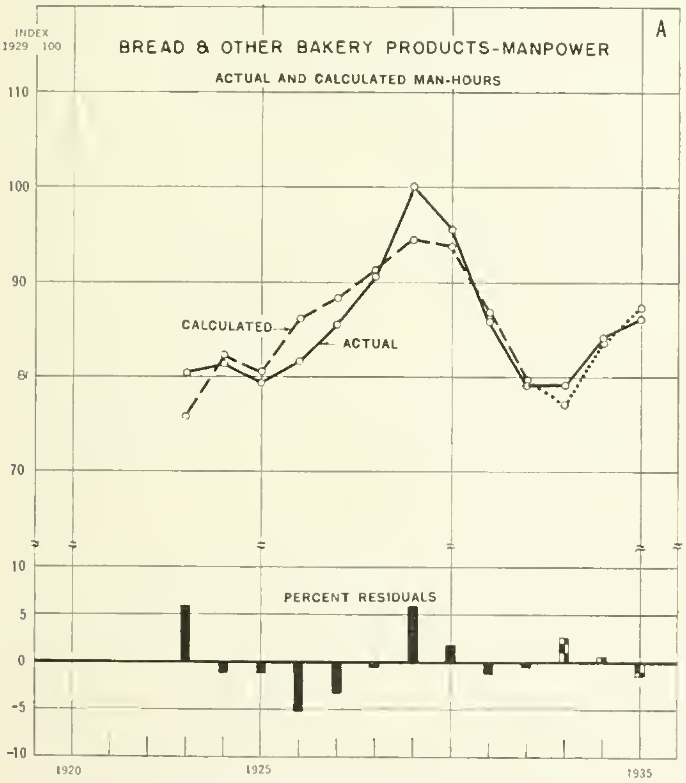

FIG 108a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION FOR THE FACTUAL DATA AND METHOD USED SEE SEE SUMMARY NO 108a IN APPENDIX

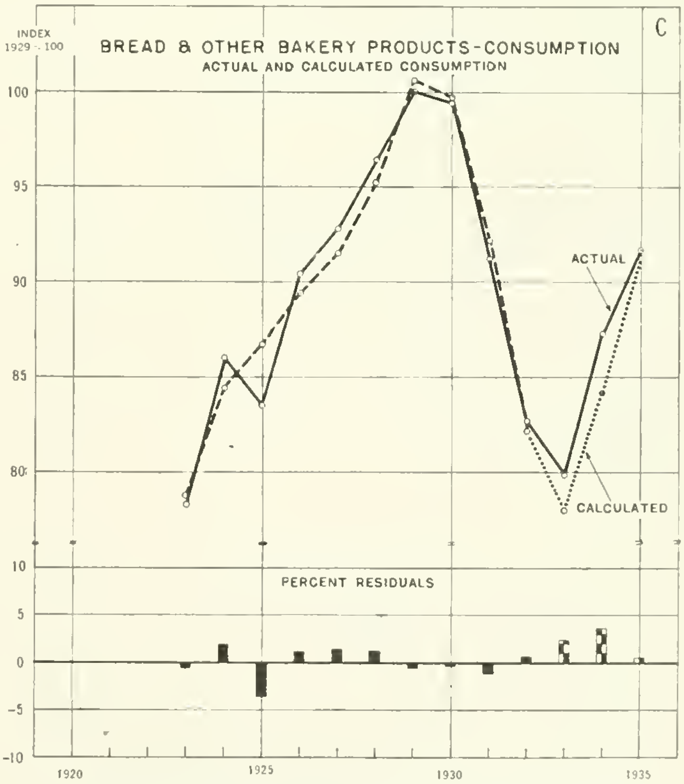

FIG. 108b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, PRODUCTION AND TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 108b IN APPENDIX

CHART XXX

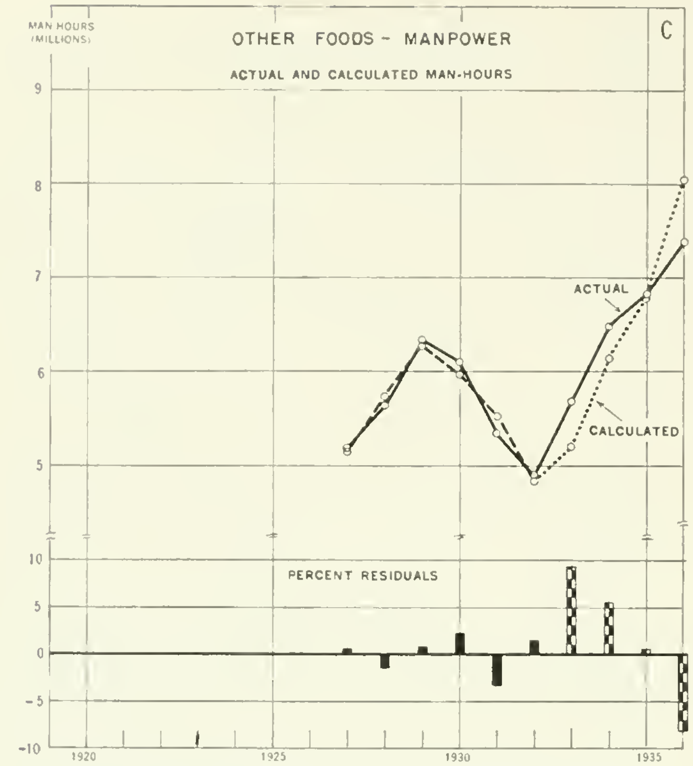

FIG 109a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 109a IN APPENDIX

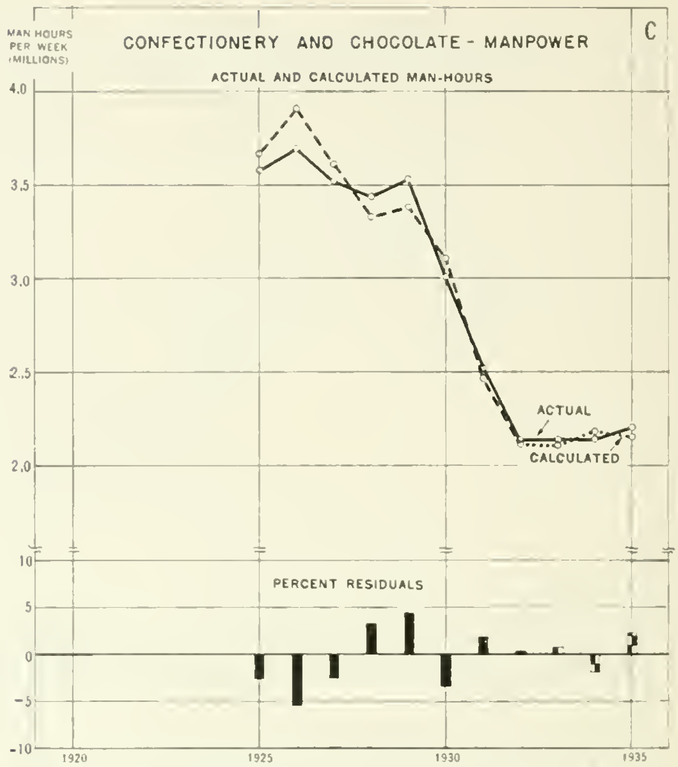

FIG 110a CALCULATED MAN-HOURS PER-WEEK ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS PER WEEK TO PRODUCTION A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 110a IN APPENDIX

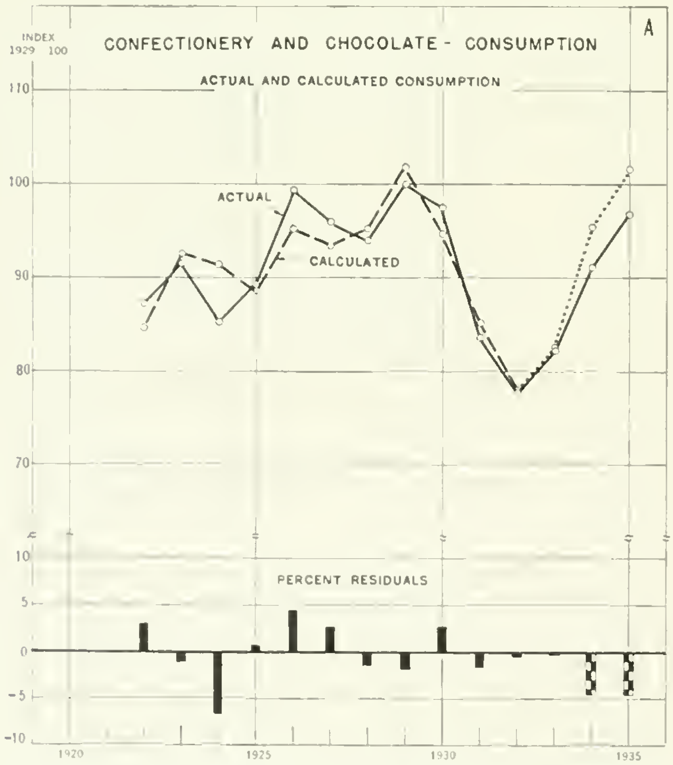

FIG 110b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO REAL PRICE, REAL INCOME OF WAGE EARNERS, REAL INCOME OF OTHER THAN WAGE-EARNERS AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO' 110b IN APPENDIX

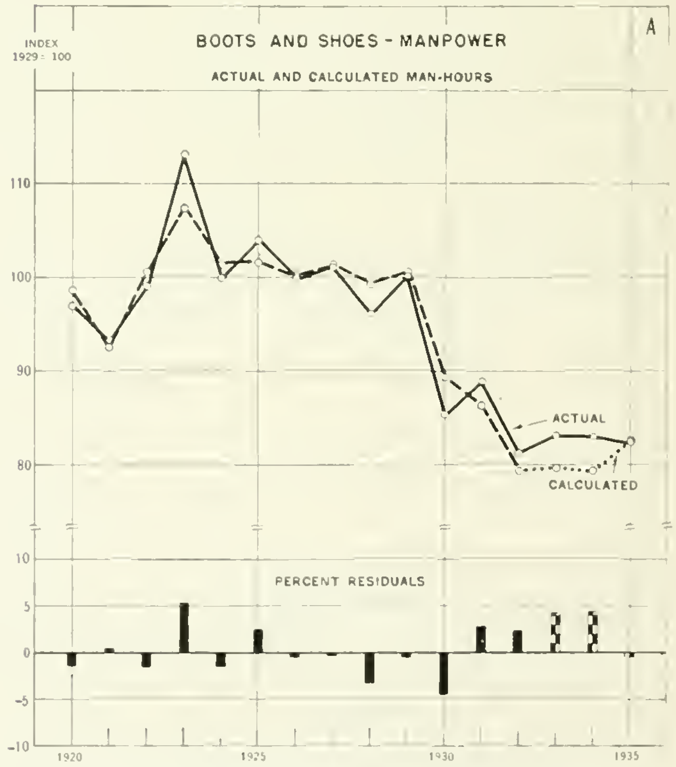

FIG. 111a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO DEFLATED OUTPUT AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 111a IN APPENDIX

CHART XXXI

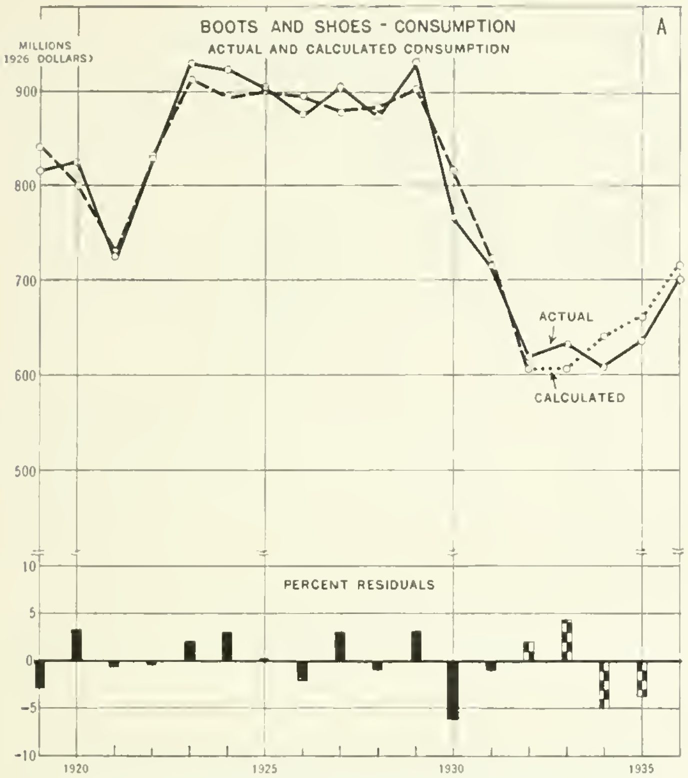

FIG. 111b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, PRICE DEFLATED BY COST OF LIVING AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 111b IN APPENDIX

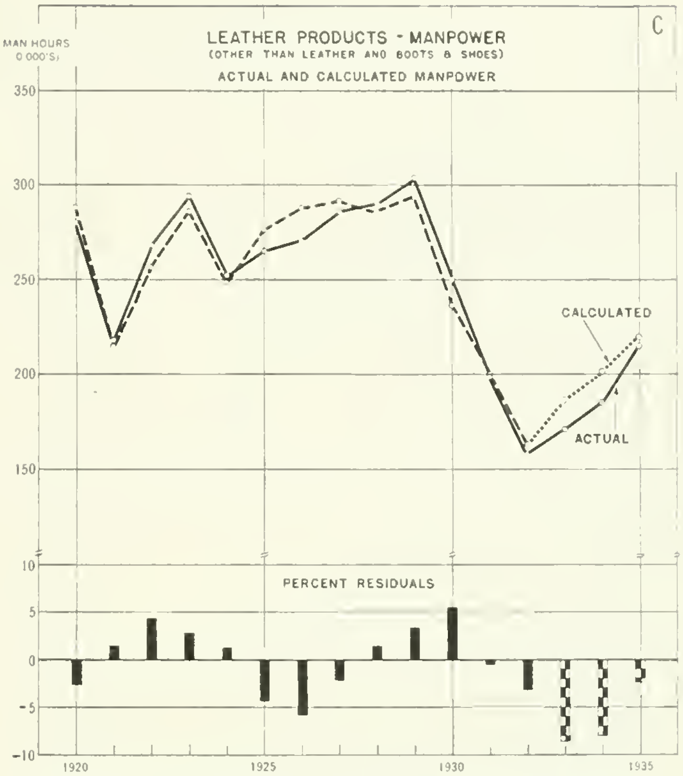

FIG 112a CALCULATED MANPOWER IS BASED ON A FORMULA WHICH RELATES MANPOWER TO OUTPUT AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 112a IN APPENDIX

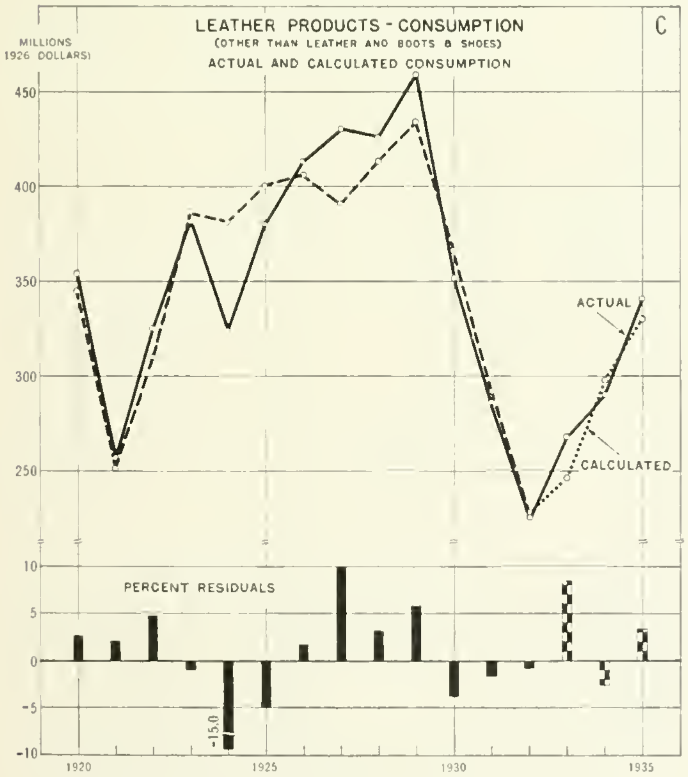

FIG. 112b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, DEFLATED PRICE OF LEATHER PRODUCTS AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 112b IN APPENDIX.

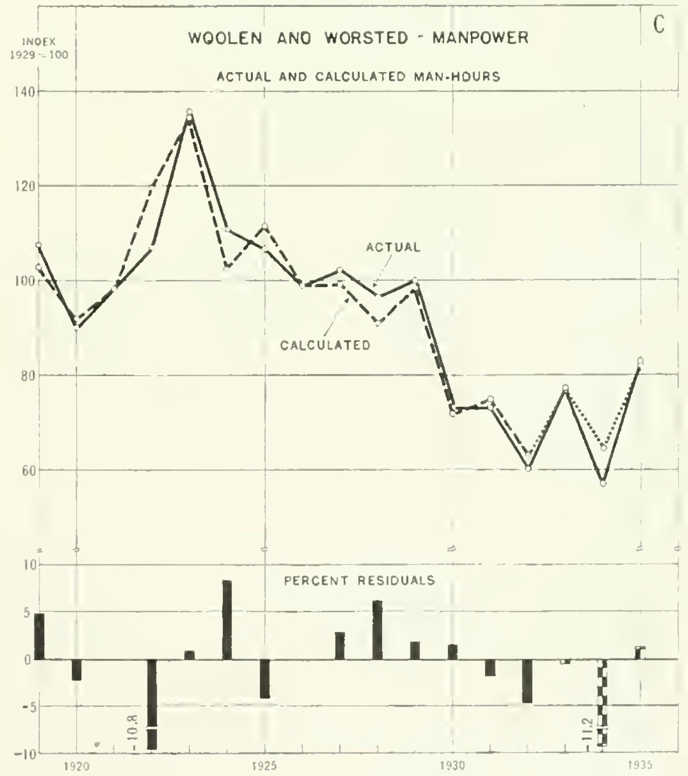

FIG 113a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 113a IN APPENDIX

CHART XXXII

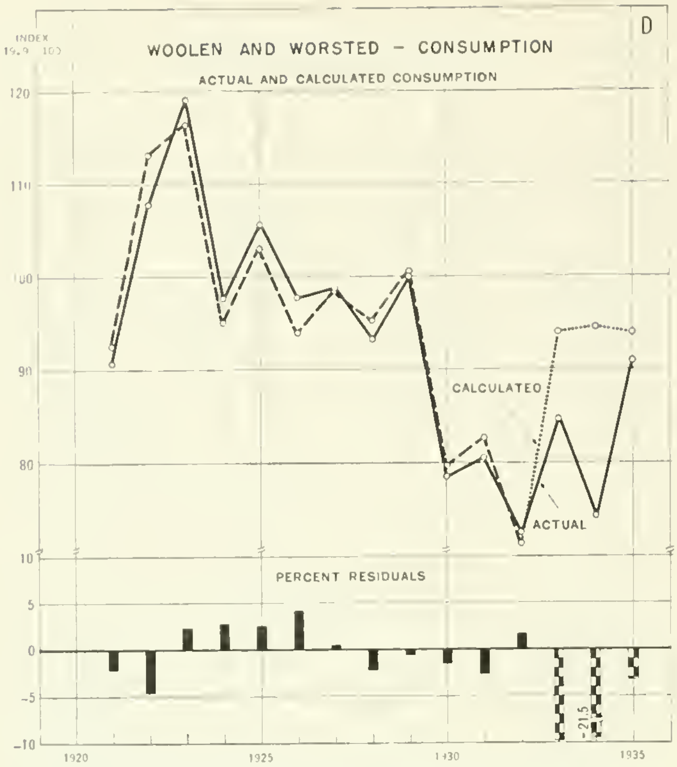

FIG 113b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 113b IN APPENDIX

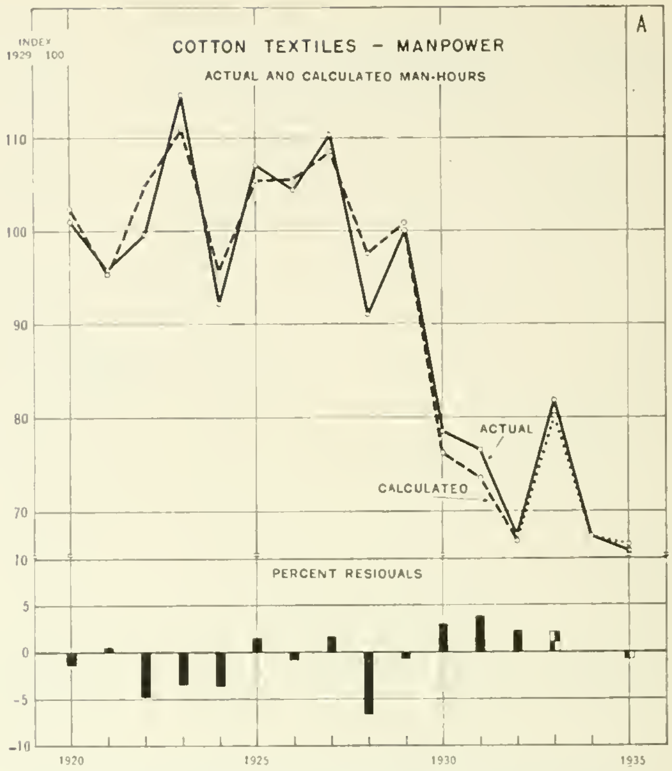

FIG. 114a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 114a IN APPENDIX

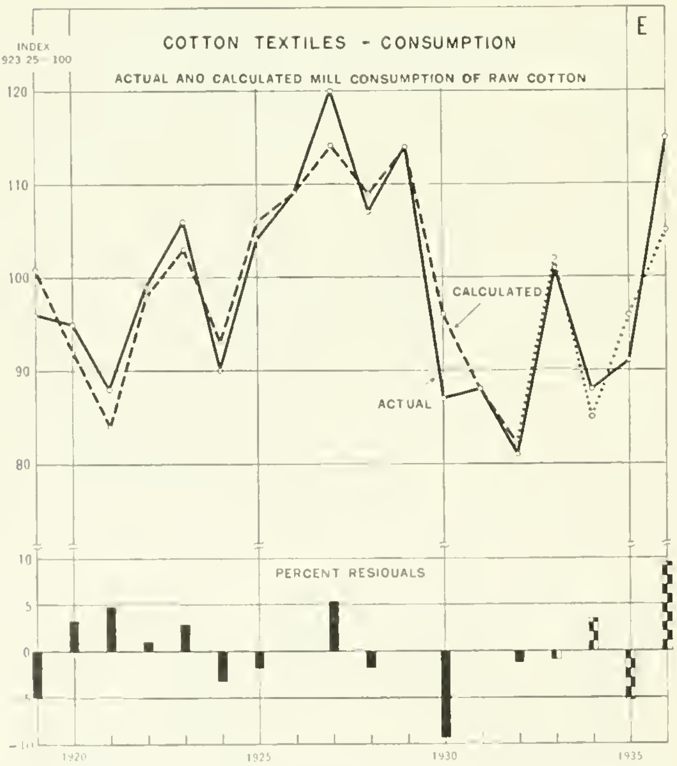

FIG 114b CALCULATED MILL CONSUMPTION OF RAW COTTON IS BASED ON A FORMULA WHICH RELATES MILL CONSUMPTION TO INDUSTRIAL PRODUCTION, RATE OF CHANGE OF COTTON GOODS PRICE, DEFLATED PRICE OF COTTON AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 114b IN APPENDIX

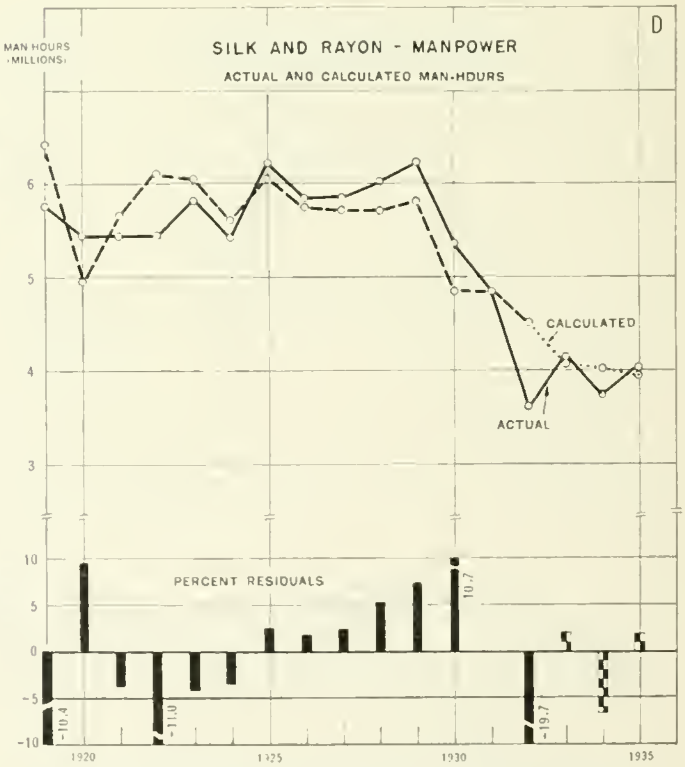

FIG. 115a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 115a IN APPENDIX.

CHART XXXIII

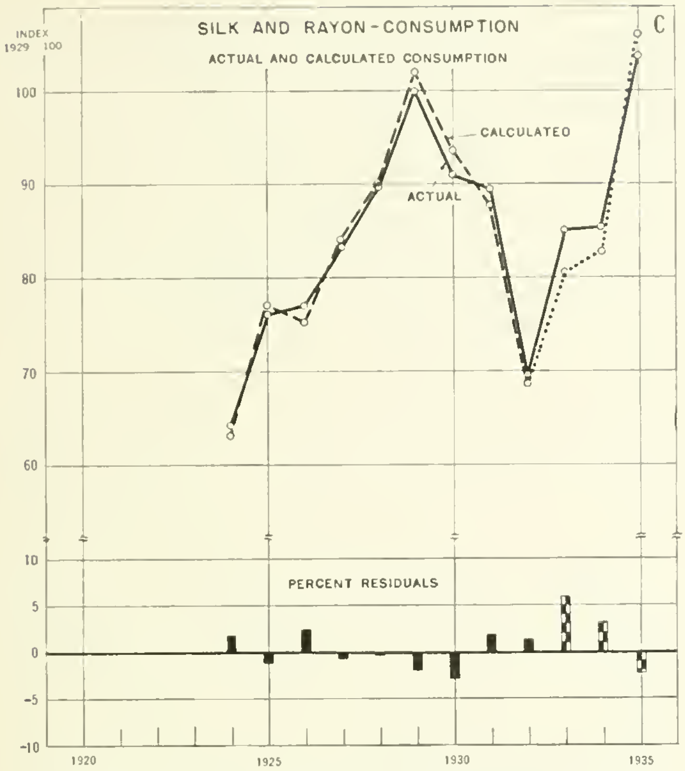

FIG 115b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND PREVIOUS YEAR CONSUMPTION AND AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 115b IN APPENDIX.

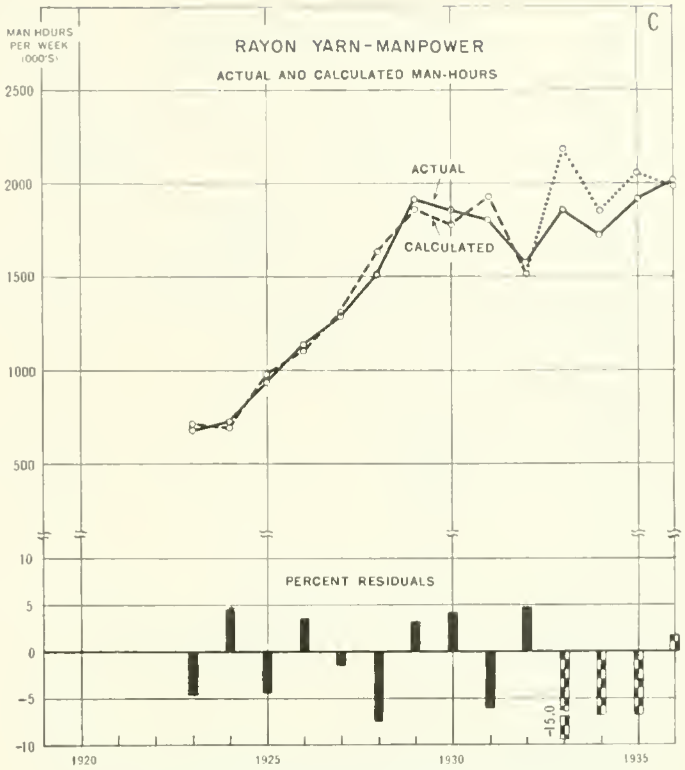

FIG 116a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 116a IN APPENDIX

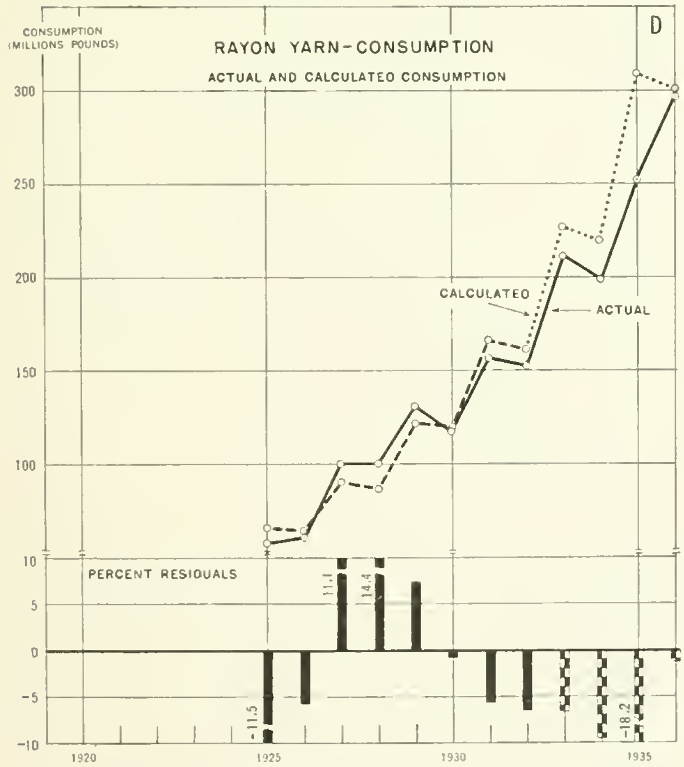

FIG 116b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, PRICE OF RAYON RELATIVE TO SILK, AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 116b IN APPENDIX

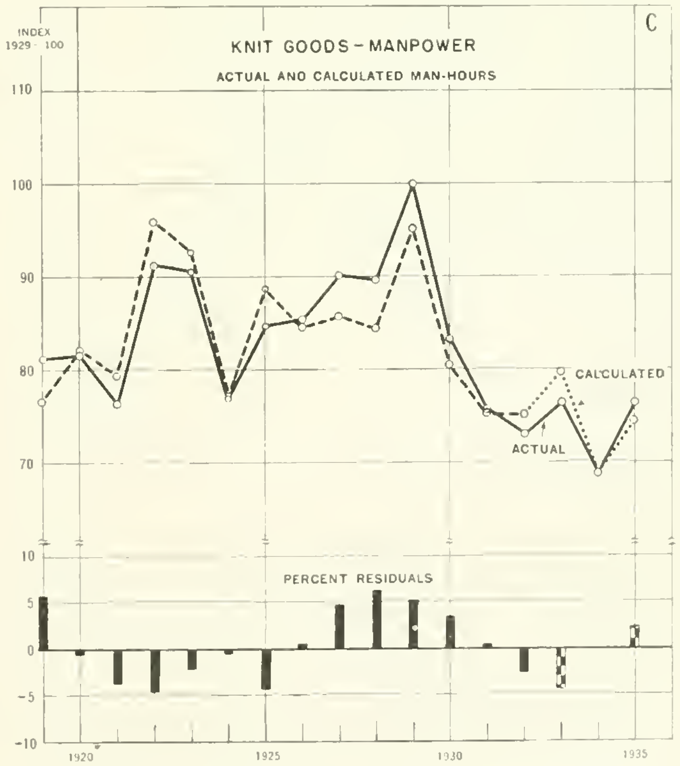

FIG 118a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 118a IN APPENDIX

CHART XXXIV

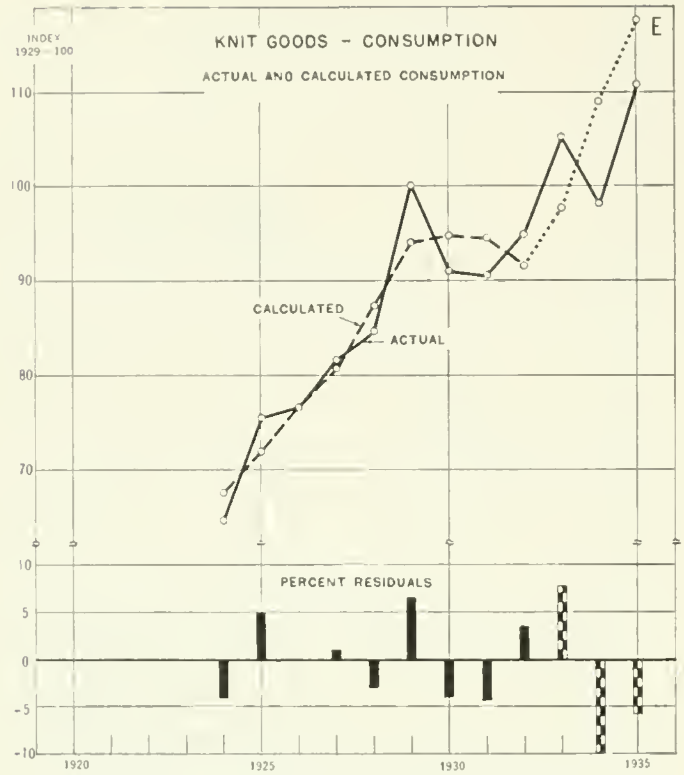

FIG. 118b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 118b IN APPENDIX.

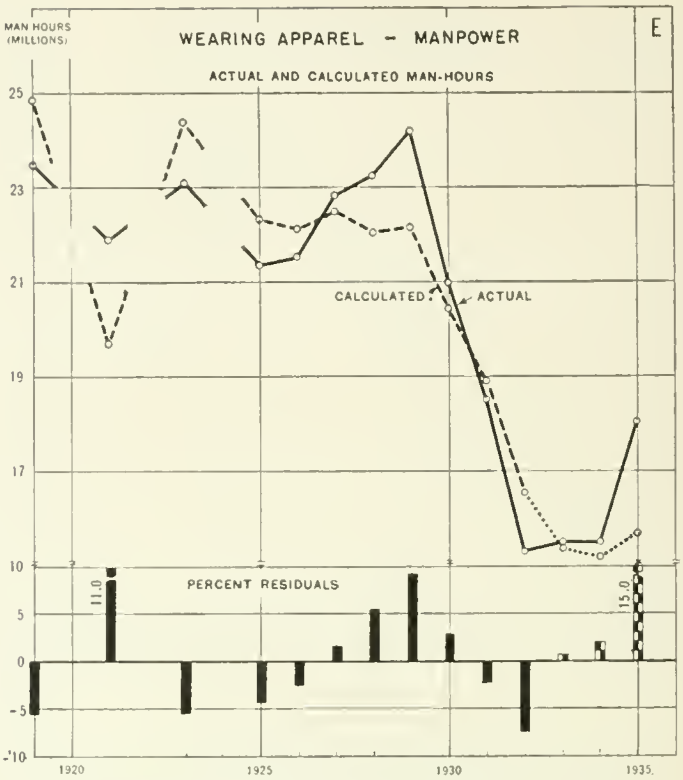

FIG. 119a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO DEFLATED OUTPUT AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 119a IN APPENDIX.

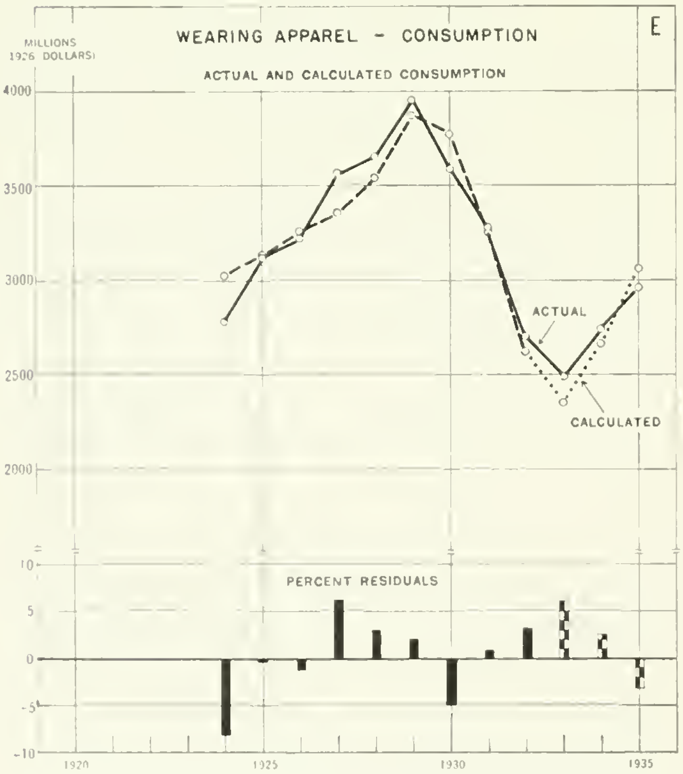

FIG. 119b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 119b IN APPENDIX.

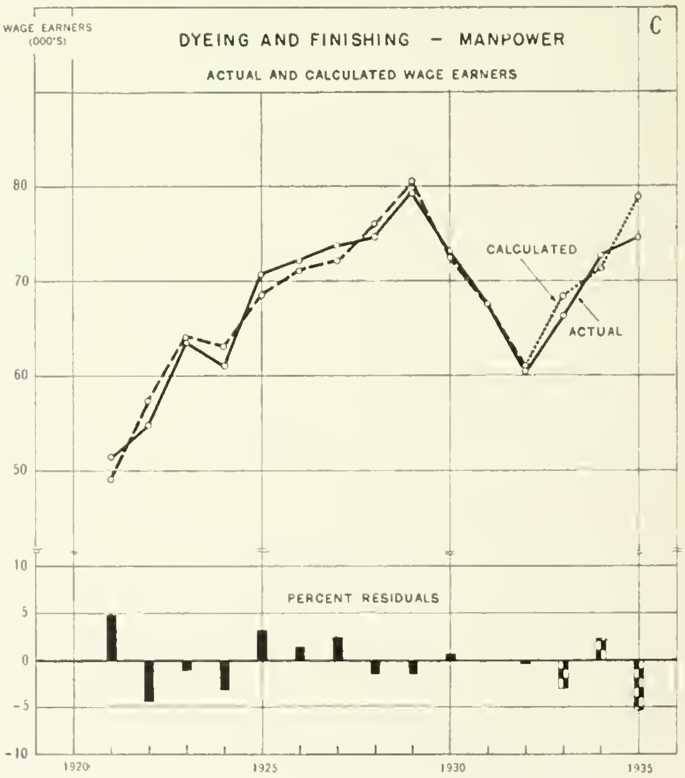

FIG. 120a CALCULATED WAGE-EARNERS ARE BASED ON A FORMULA WHICH RELATES WAGE-EARNERS TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 120a IN APPENDIX.

CHART XXXV

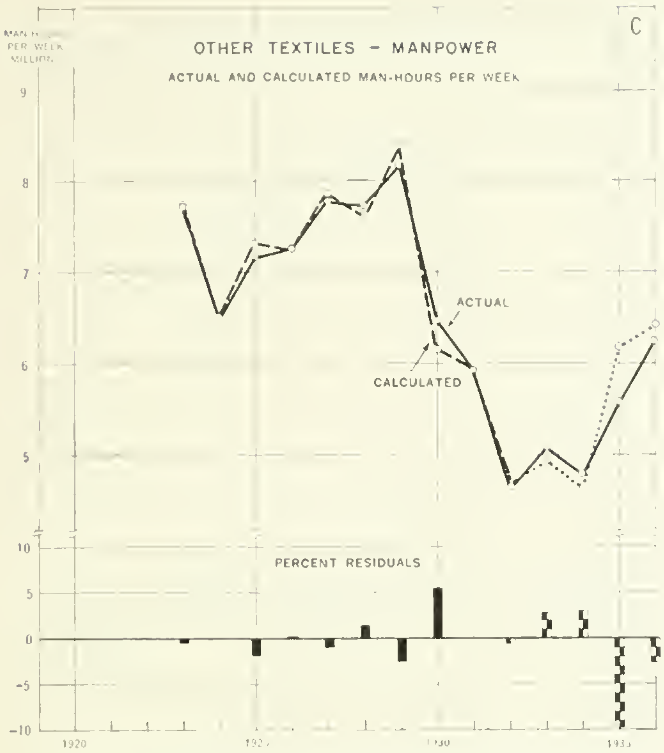

FIG. 120a CALCULATED MAN-HOURS PER WEEK ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS PER WEEK TO DEFLATED OUTPUT AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 120a IN APPENDIX.

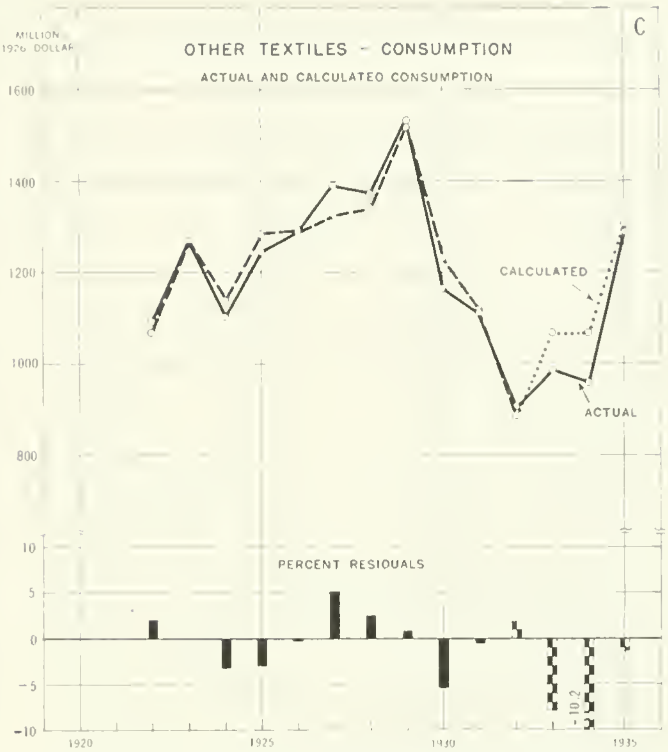

FIG. 120.b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDUSTRIAL PRODUCTION, REAL PRICE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 120b IN APPENDIX

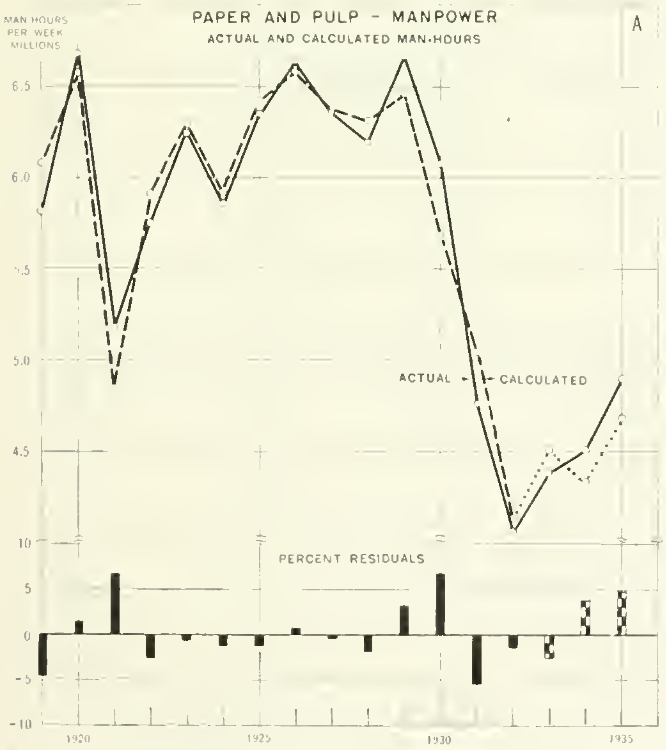

FIG. 121a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 121a IN APPENDIX.

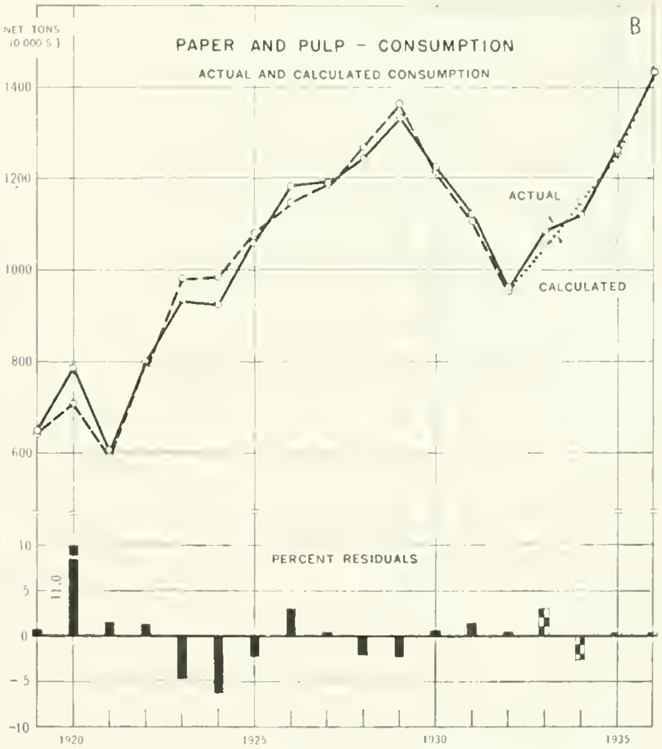

FIG. 121b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, INDUSTRIAL PRODUCTION, AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 121 IN APPENDIX

CHART XXXVI

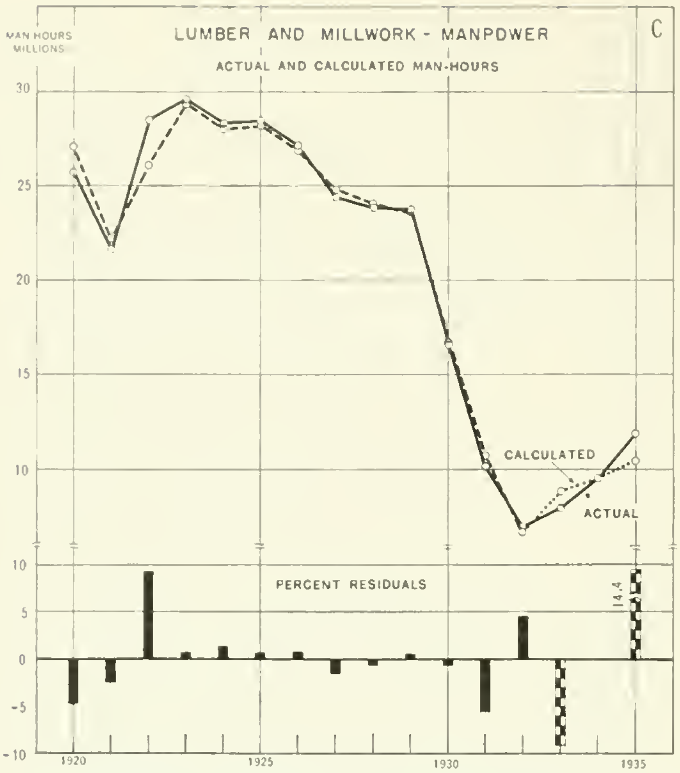

FIG 122a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 122a IN APPENDIX

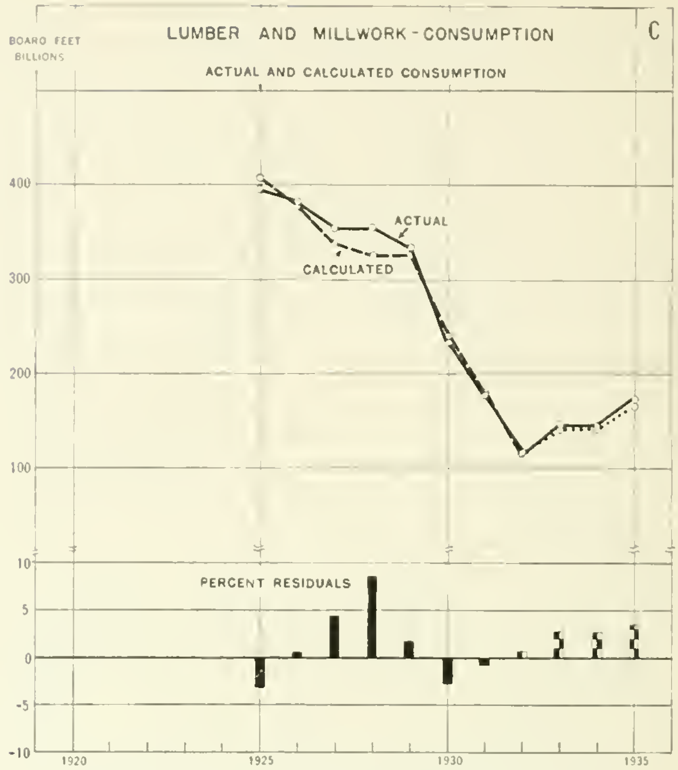

FIG 122b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDUSTRIAL PRODUCTION AND AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 122b IN APPENDIX

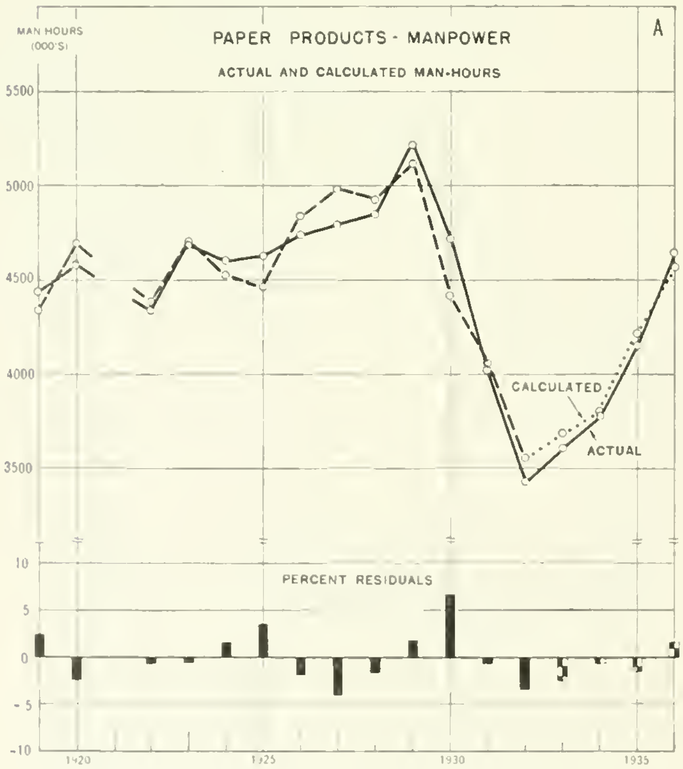

FIG 123a CALCULATED MANPOWER IS BASED ON A FORMULA WHICH RELATES MAN-HOURS TO DEFLATED OUTPUT AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 123a IN APPENDIX

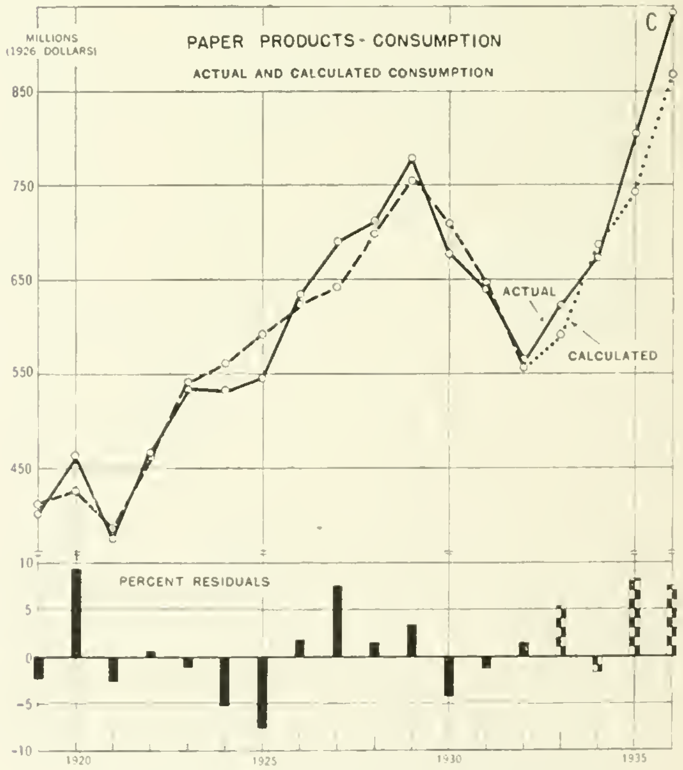

FIG 123b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 123b IN APPENDIX

CHART XXXVII

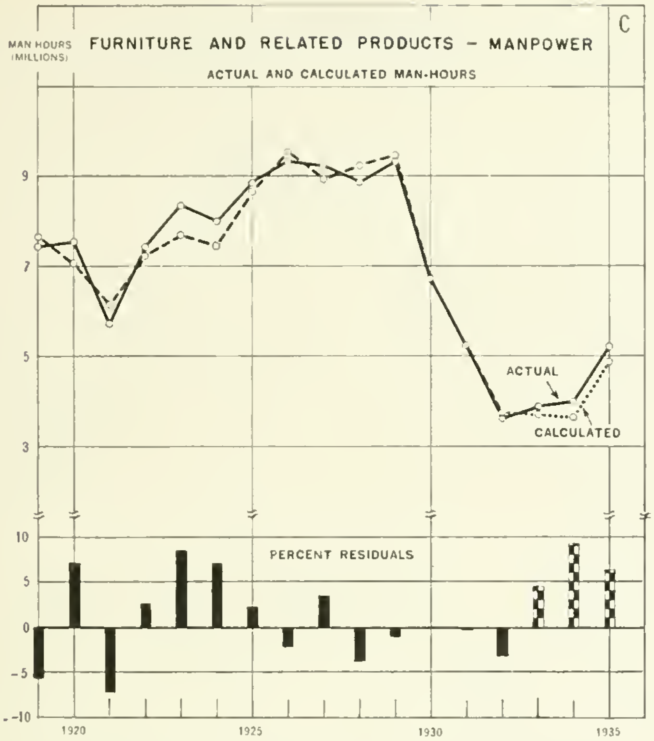

FIG. 124a CALCULATED MANHOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO DEFLATED VALUE OF PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 124a IN APPENDIX.

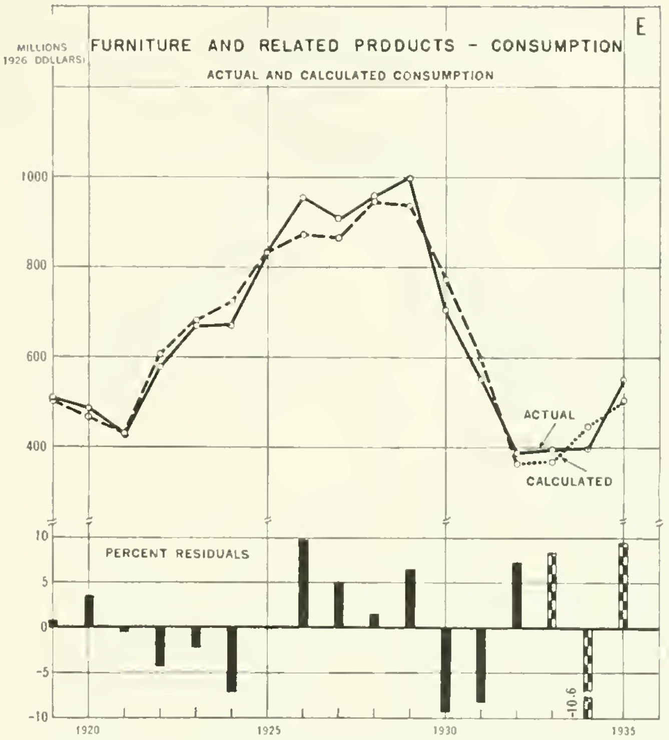

FIG. 124b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, CONSTRUCTION VALUE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 124b IN APPENDIX

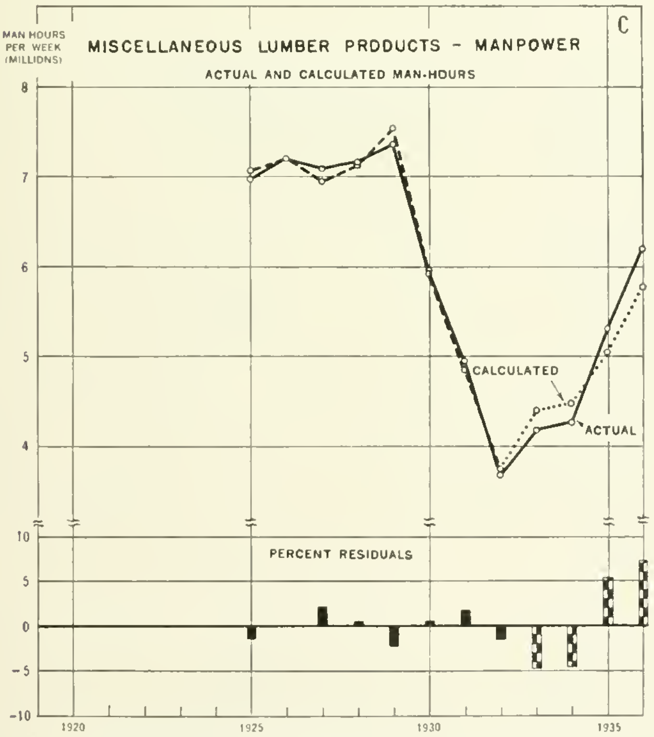

FIG. 125a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 125a IN APPENDIX

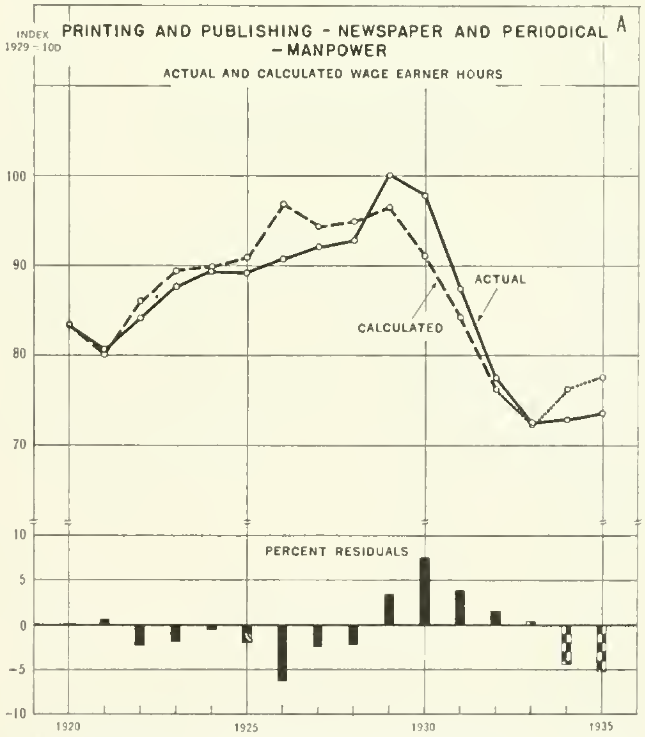

FIG 128a CALCULATED WAGE-EARNER HOURS ARE BASED ON A FORMULA WHICH RELATES WAGE-EARNERS HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 126a IN APPENDIX.

CHART XXXVIII

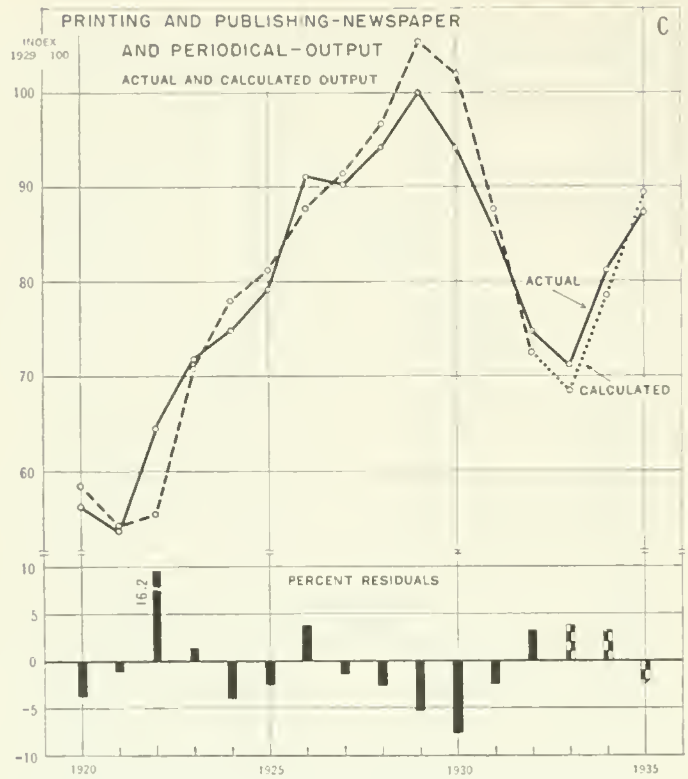

FIG 126b CALCULATED OUTPUT IS BASED ON A FORMULA WHICH RELATES OUTPUT TO AN AVERAGE OF INDUSTRIAL PRODUCTION AND CONSUMERS INCOME, AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 126b IN APPENDIX.

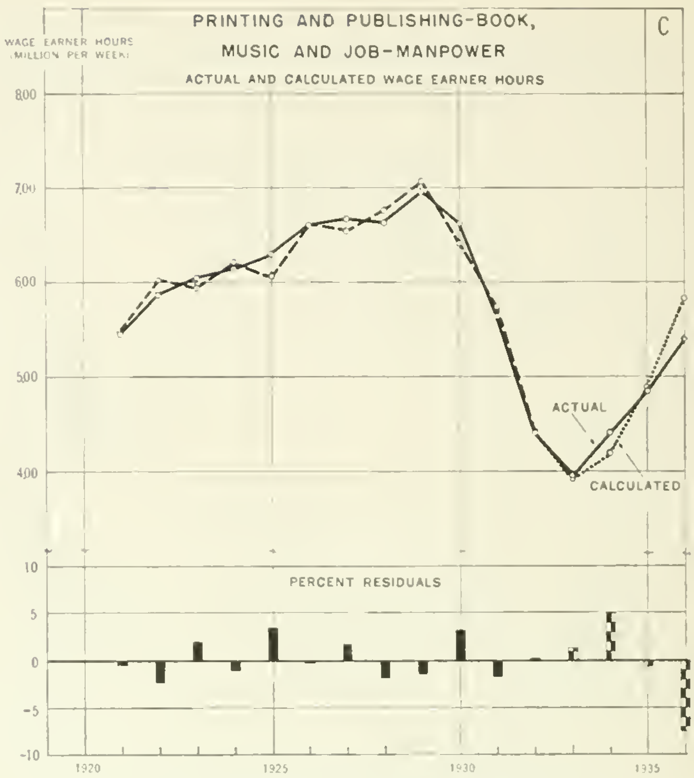

FIG. 126 1a CALCULATED WAGE-EARNERS HOURS ARE BASED ON A FORMULA WHICH RELATES WAGE-EARNERS HOURS TO VALUE OF PRODUCT DEFLATED BY COST OF LIVING. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 126 1a IN APPENDIX.

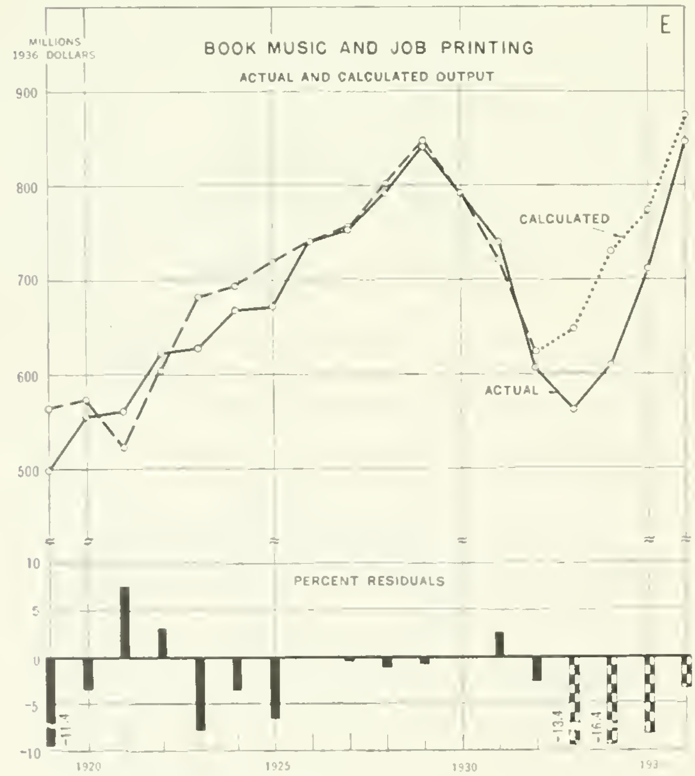

FIG. 126 1b CALCULATED OUTPUT IS BASED ON A FORMULA WHICH RELATES OUTPUT TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 126 1b IN APPENDIX

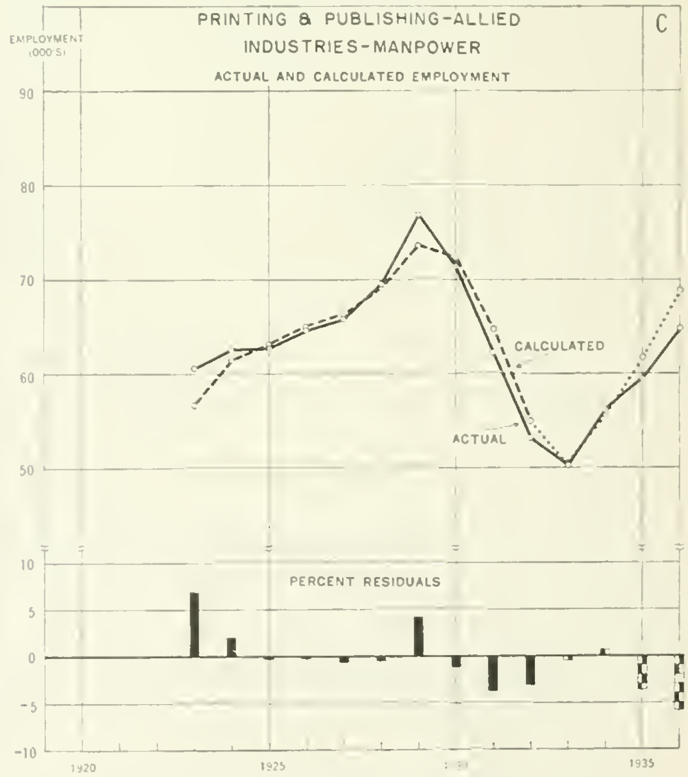

FIG 126 2a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 126 2a IN APPENDIX

CHART XXXIX

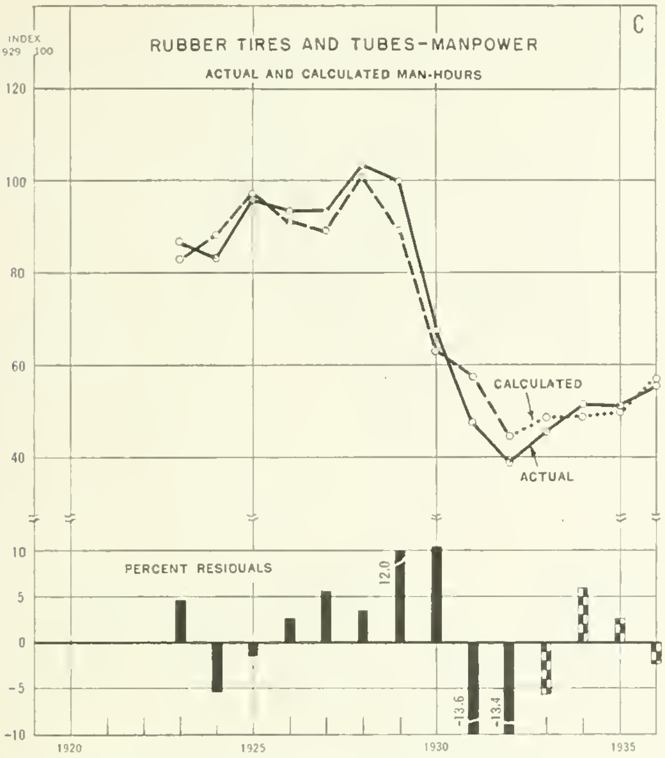

FIG 127a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 127a IN APPENDIX.

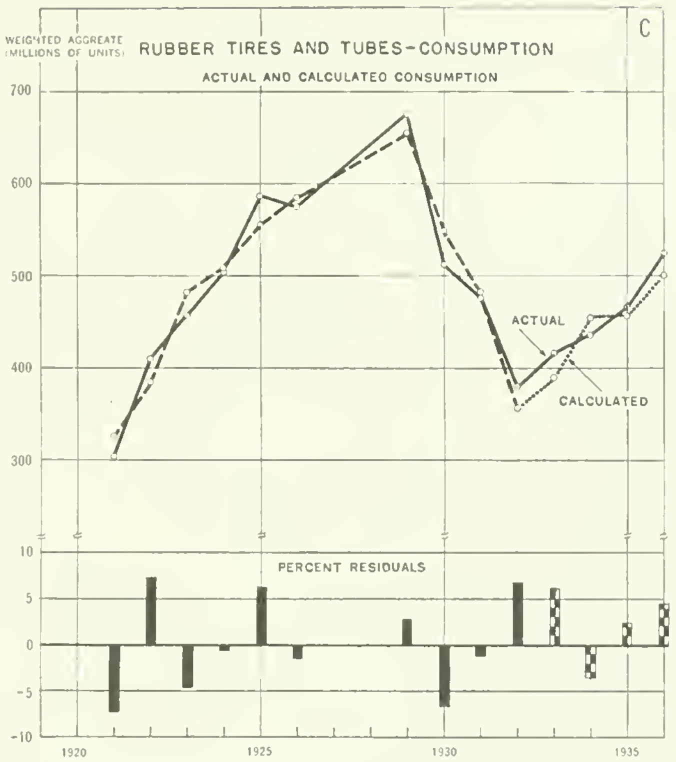

FIG. 127b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INCREASE IN REGISTRATION DURING YEAR, TOTAL TIRES WORN OUT, AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 127b IN APPENDIX

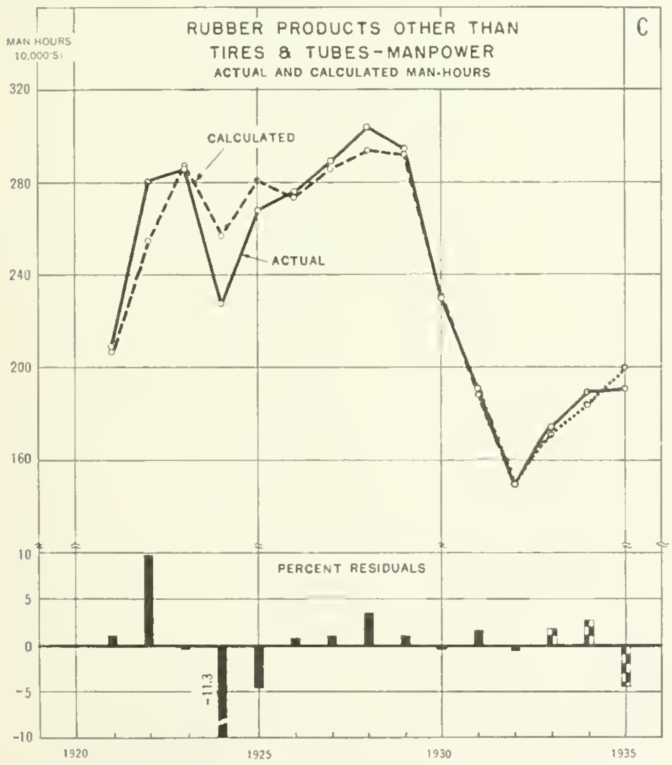

FIG 128a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO OTHER RUBBER PRODUCTS AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 128a IN APPENDIX.

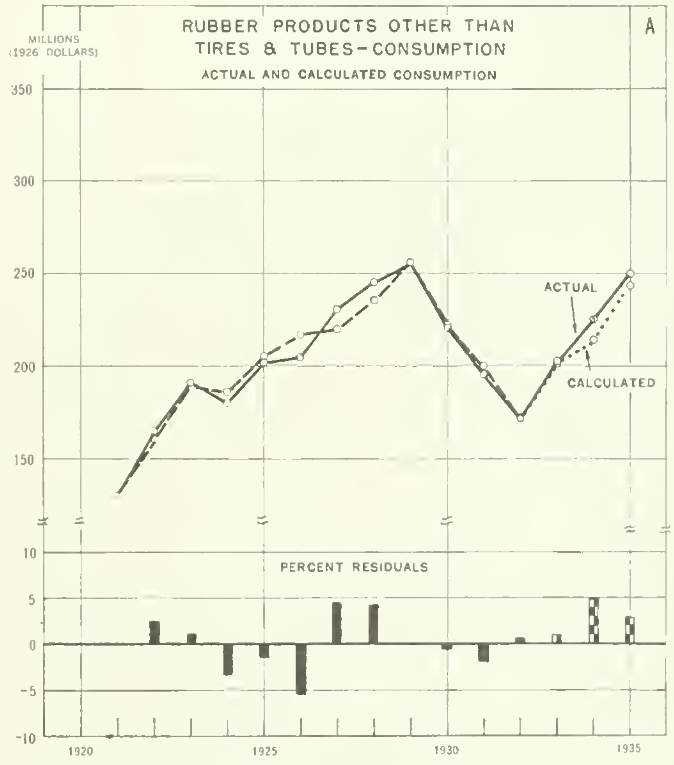

FIG. 128b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDUSTRIAL PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 128b IN APPENDIX

CHART XL

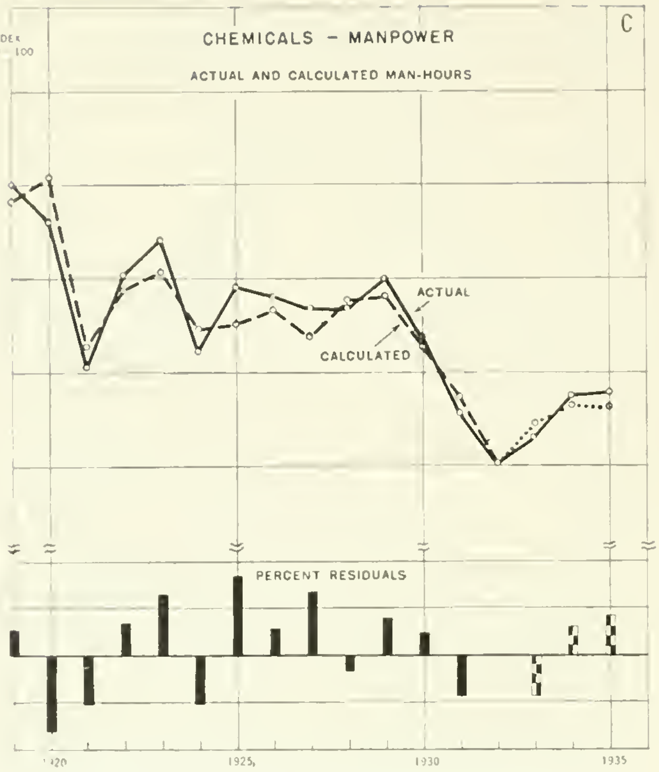

FIG. 129a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 129a IN APPENDIX.

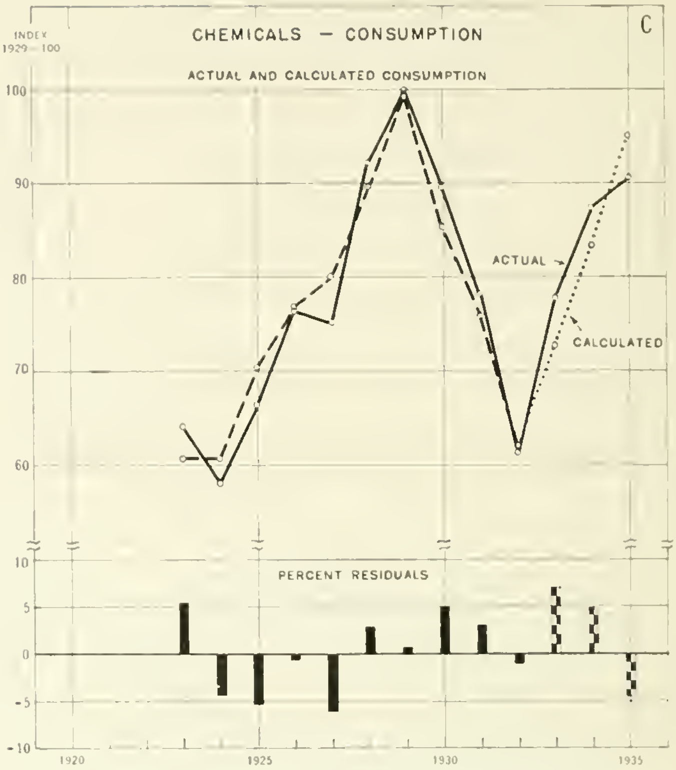

FIG. 129b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO AN AVERAGE OF INDUSTRIAL PRODUCTION AND CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 129b IN APPENDIX.

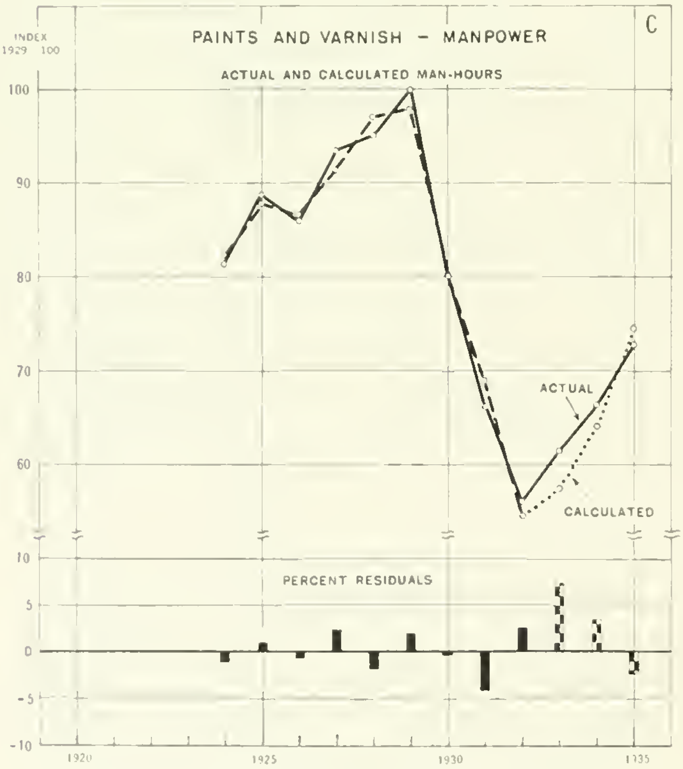

FIG. 129 1a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 129 1a IN APPENDIX.

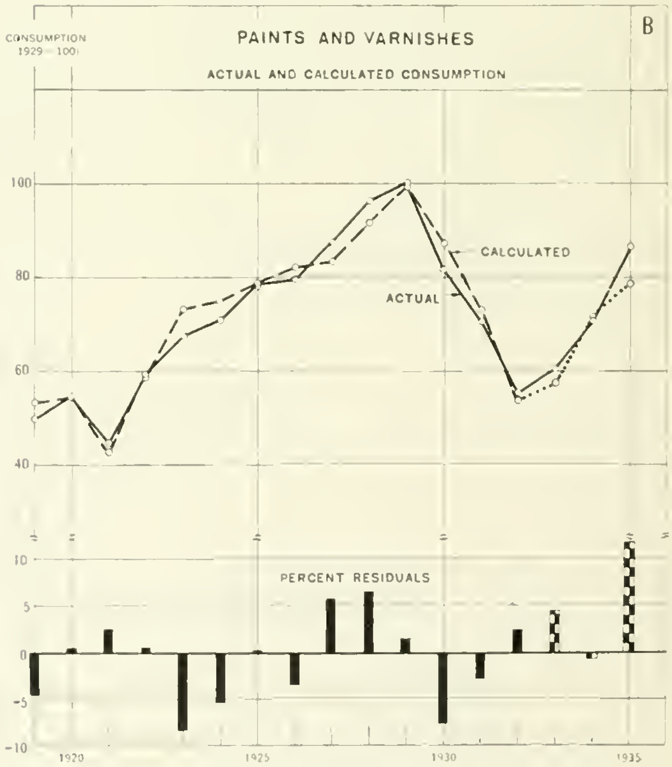

FIG. 129 1b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 129.1b IN APPENDIX.

CHART XLI

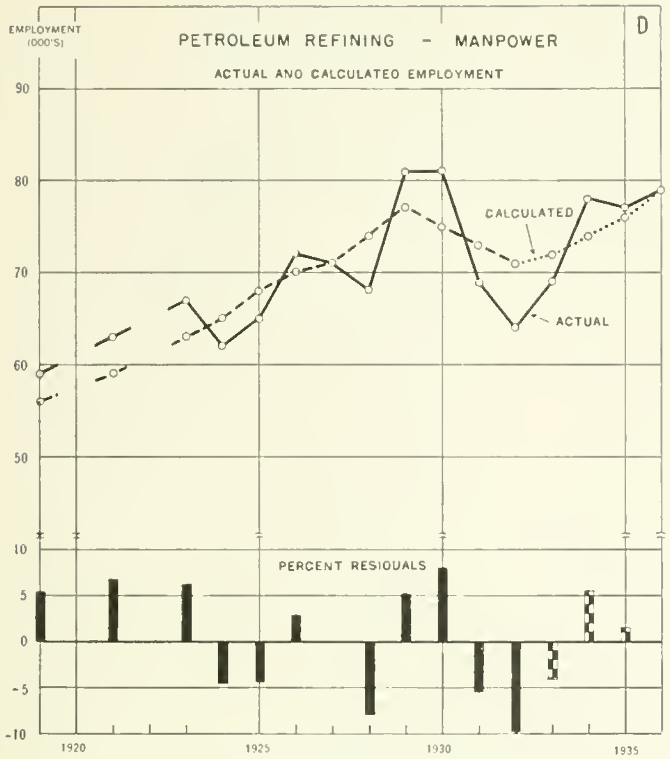

FIG 131a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO OIL RUN TO STILLS. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 131a IN APPENDIX

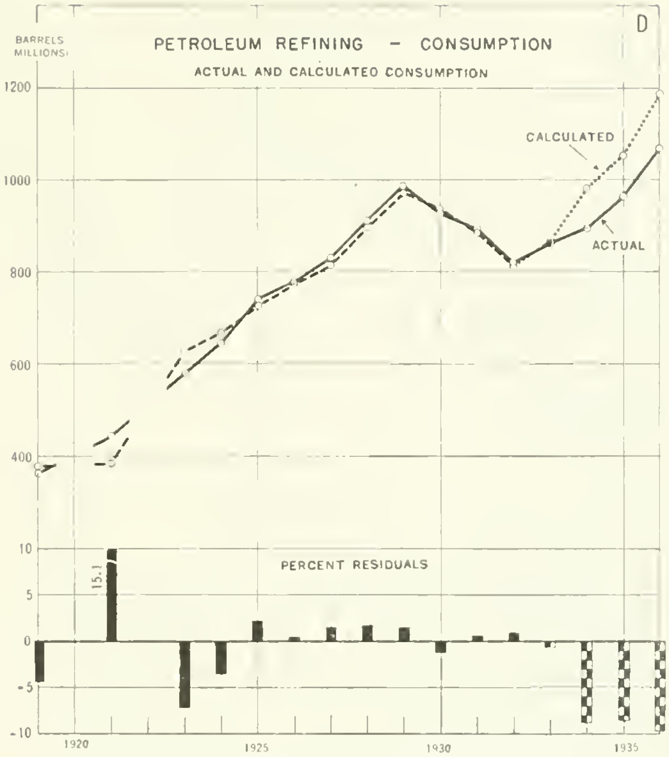

FIG. 131b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 131b IN APPENDIX.

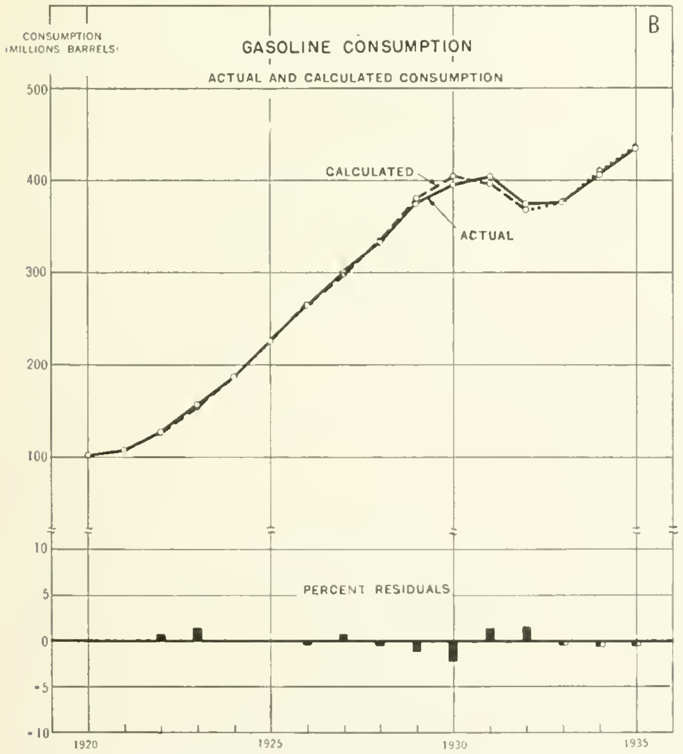

FIG 131c CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES GASOLINE CONSUMPTION TO CONSUMER INCOME, EQUATED CARS IN USED AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 131c IN APPENDIX

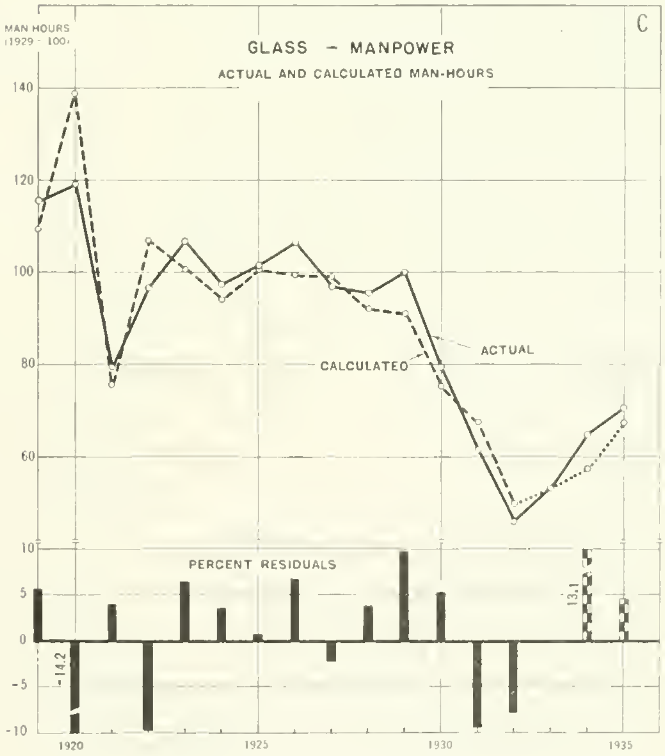

FIG 132a CALCULATED MANPOWER IS BASED ON A FORMULA WHICH RELATES MANPOWER TO GLASS PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 132a IN APPENDIX

CHART XLII

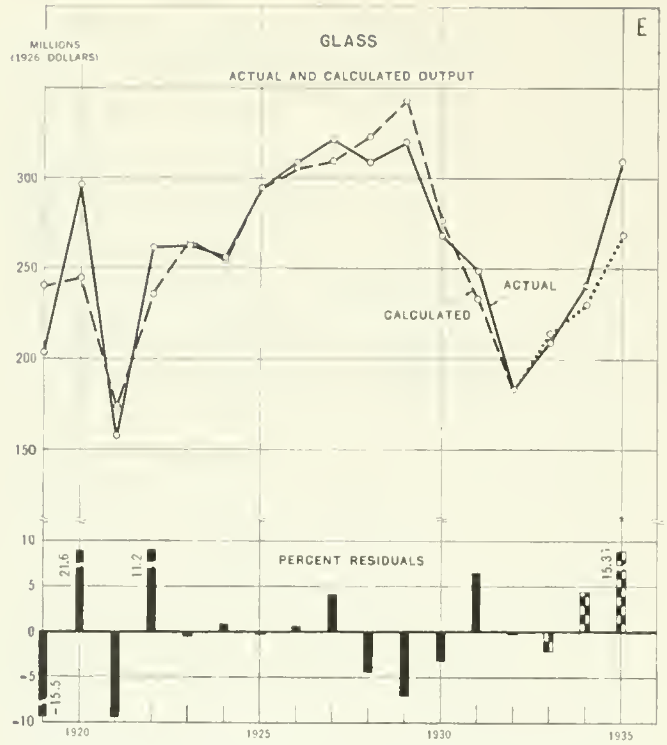

FIG. 132b CALCULATED OUTPUT IS BASED ON A FORMULA WHICH RELATES OUTPUT TO INDUSTRIAL PRODUCTION, DEFLATED PRICE OF GLASS PRODUCTS AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 132b IN APPENDIX.

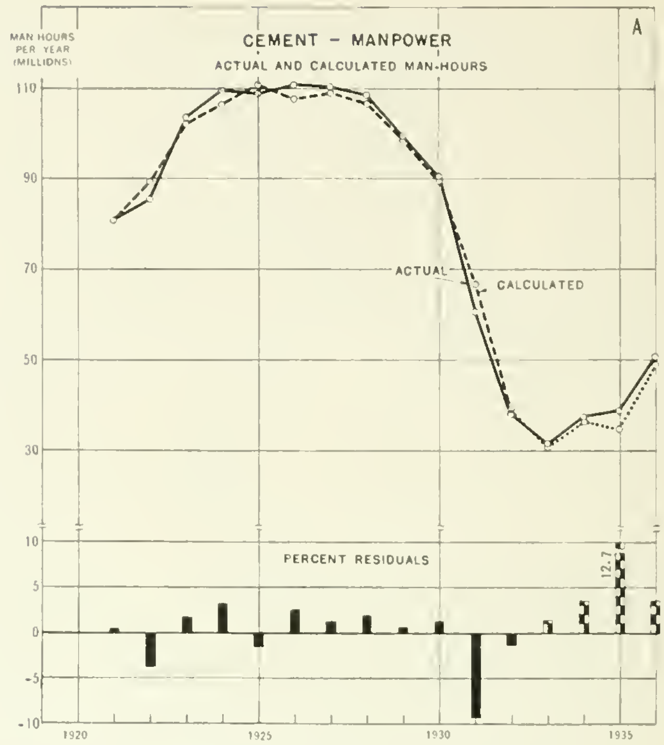

FIG. 133a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 133a IN APPENDIX.

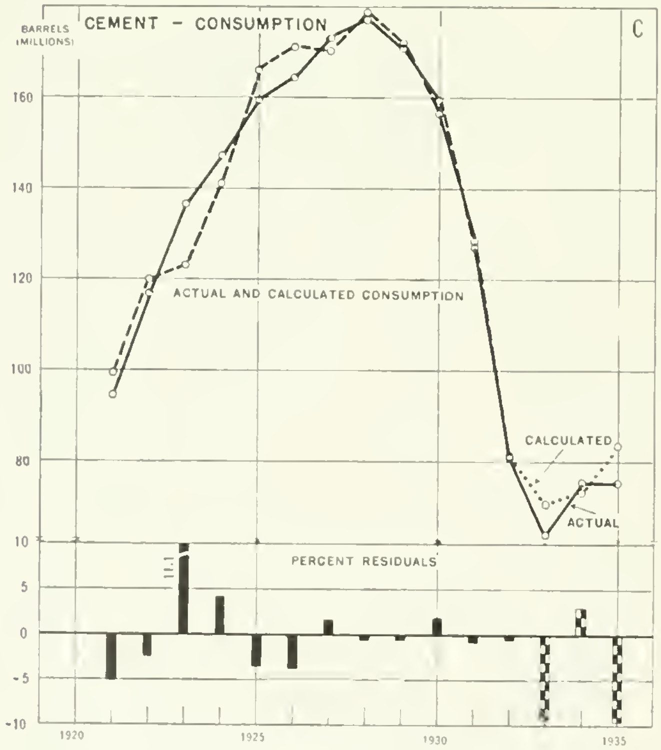

FIG. 133b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, CONSTRUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 133b IN APPENDIX

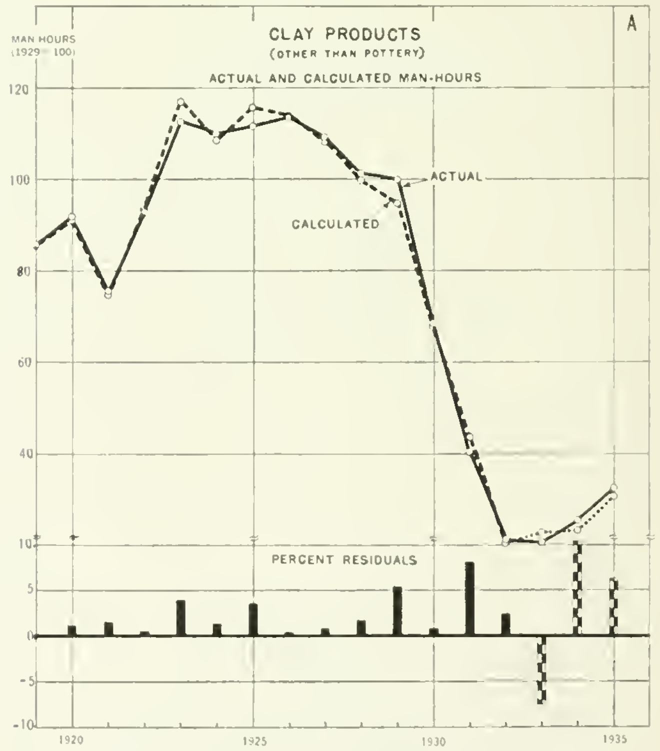

FIG. 134a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 134a IN APPENDIX.

CHART XLIII

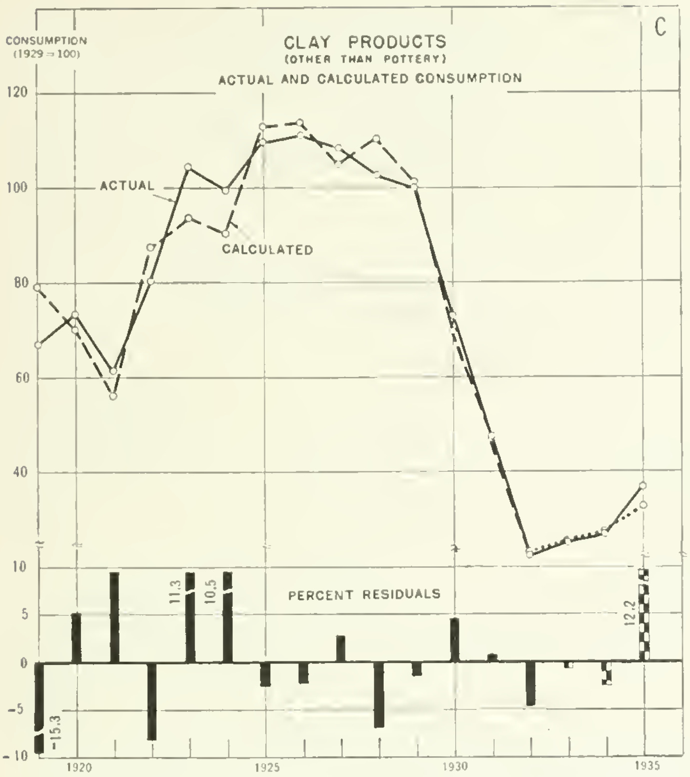

FIG. 134 2b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDEX OF MANUFACTURES (EXCLUDING MINING), DEFLATED VALUE OF CONSTRUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 134 b IN APPENDIX

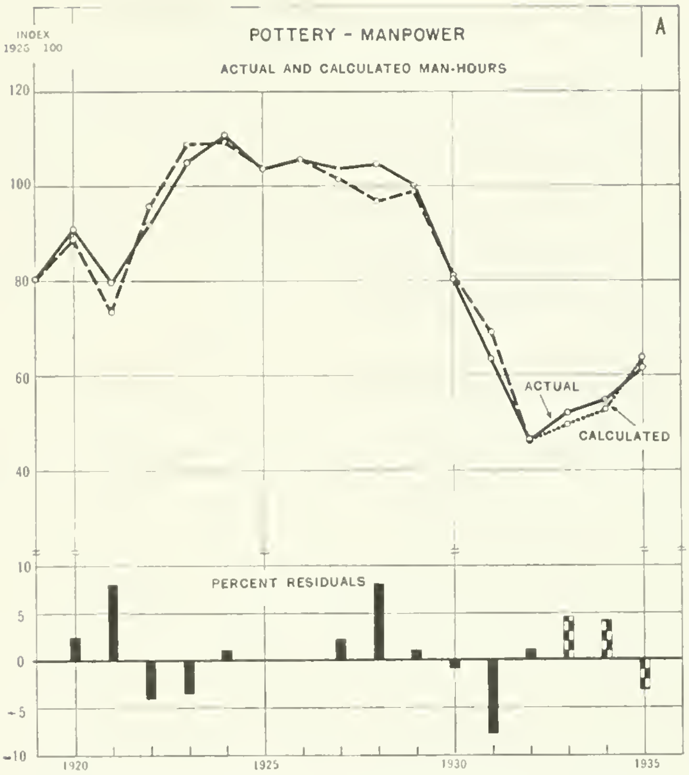

FIG 134 1a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 134 1 IN APPENDIX

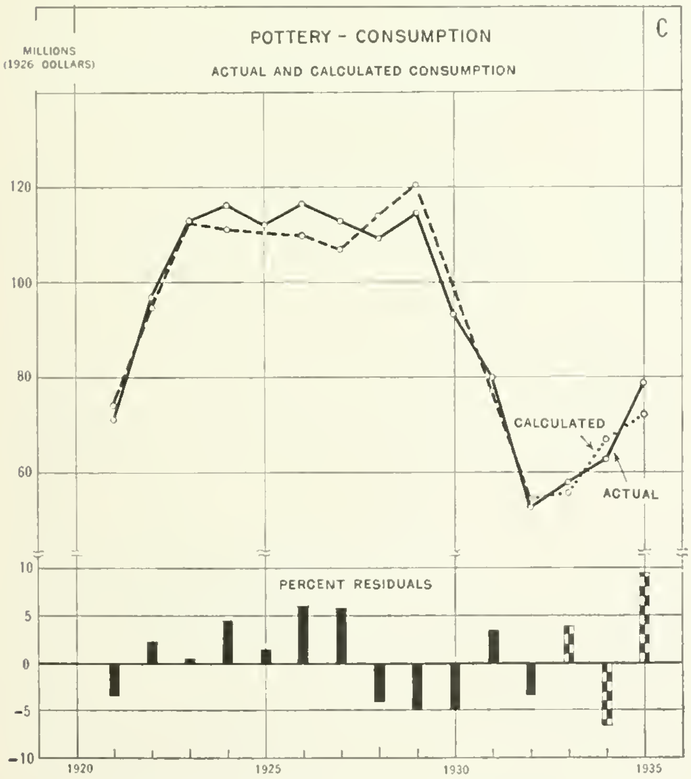

FIG. 134 1b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 134 1b IN APPENDIX

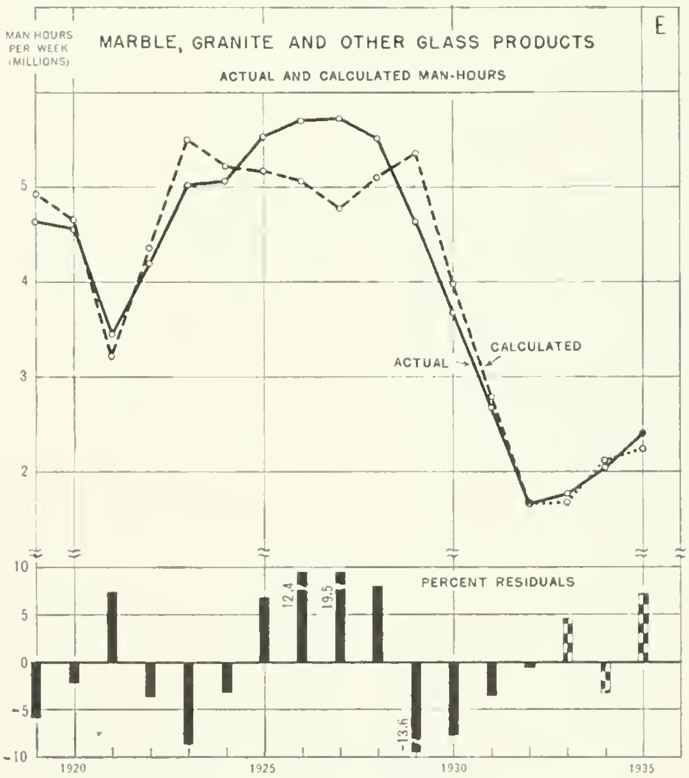

FIG. 134 2a CALCULATED MANPOWER IS BASED ON A FORMULA WHICH RELATES MAN-HOURS TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 134 2a IN APPENDIX

CHART XLIV

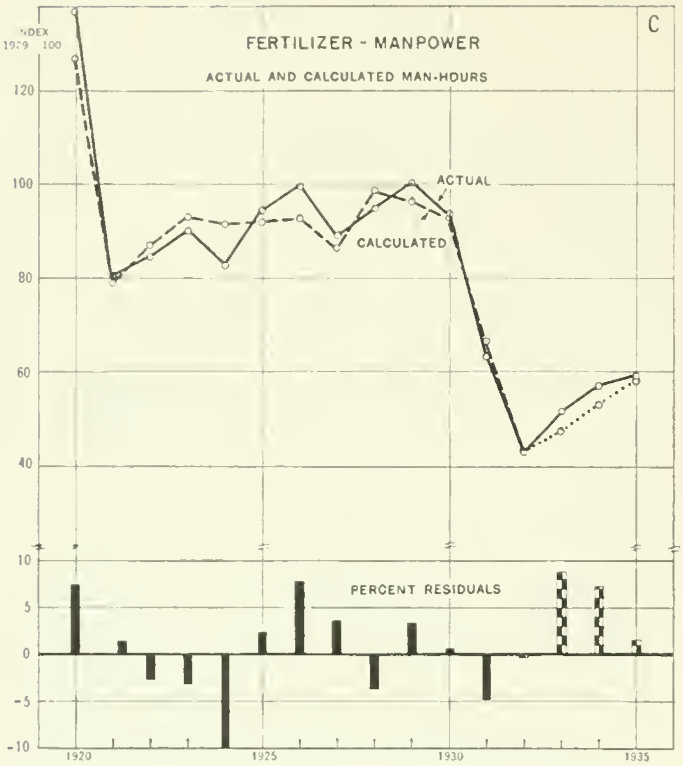

FIG. 135a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 135a IN APPENDIX

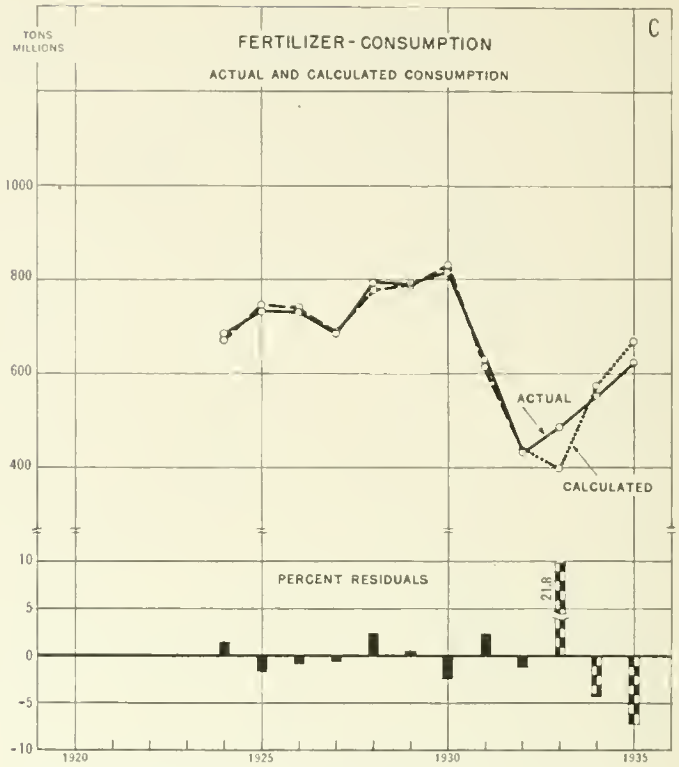

FIG 135b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CASH GROUP INCOME, DEFLATED BY PRICES PAID, RATIO OF PRICES RECEIVED TO PRICES PAID BY FARMERS AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 135b IN APPENDIX

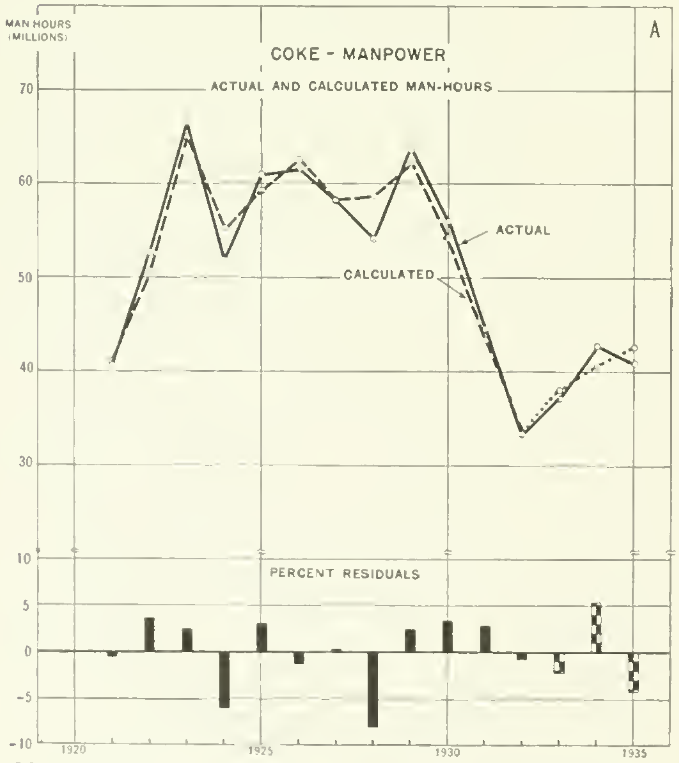

FIG 136a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO BITUMINOUS COAL CONSUMED AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 136a IN APPENDIX

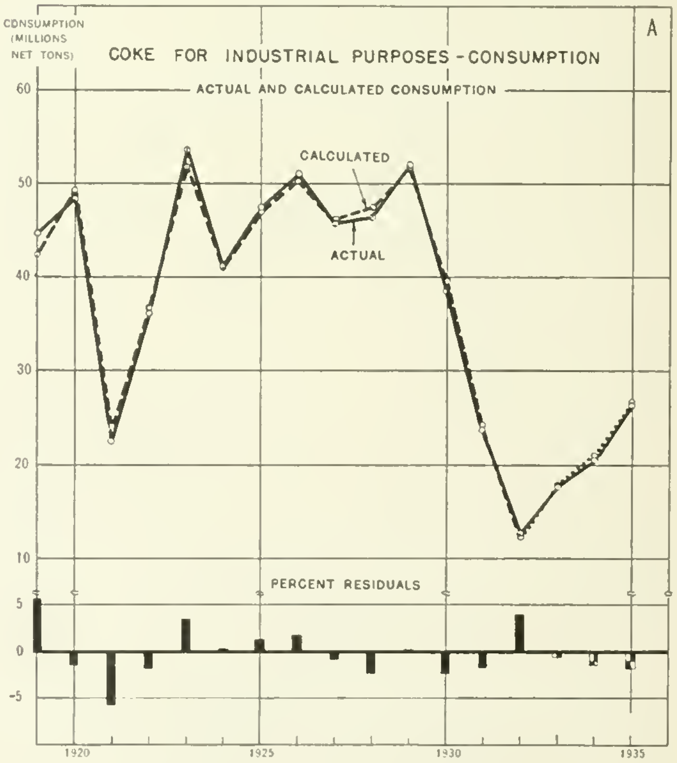

FIG 136b CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES CONSUMPTION TO PIG IRON PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 136b IN APPENDIX

CHART XLV

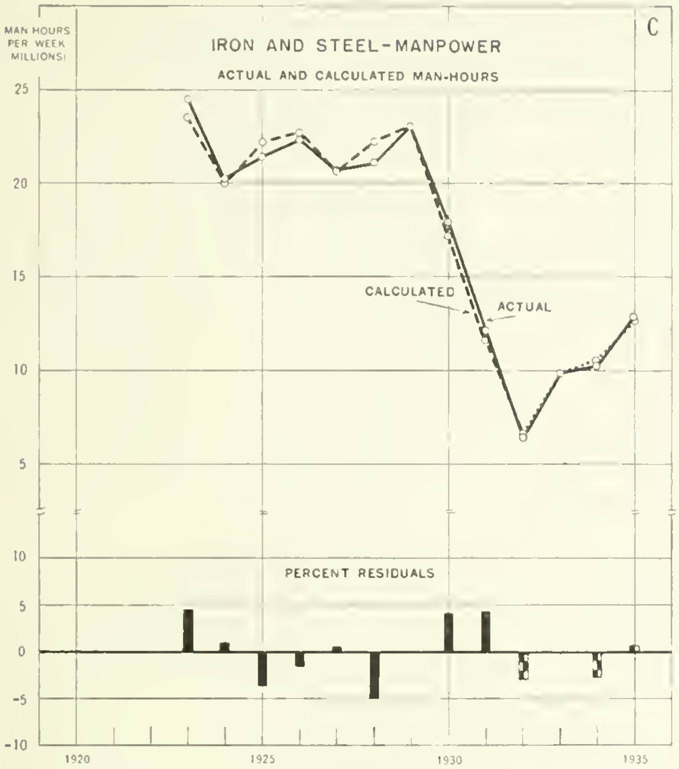

FIG 137a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 137a IN APPENDIX

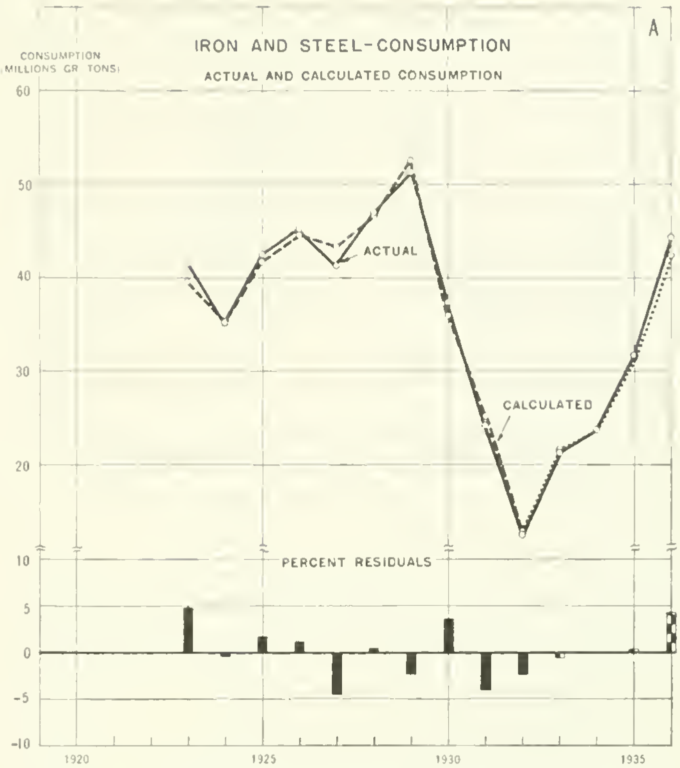

FIG 137b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES IRON AND STEEL CONSUMPTION TO INDUSTRIAL PRODUCTION FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY 137b IN APPENDIX

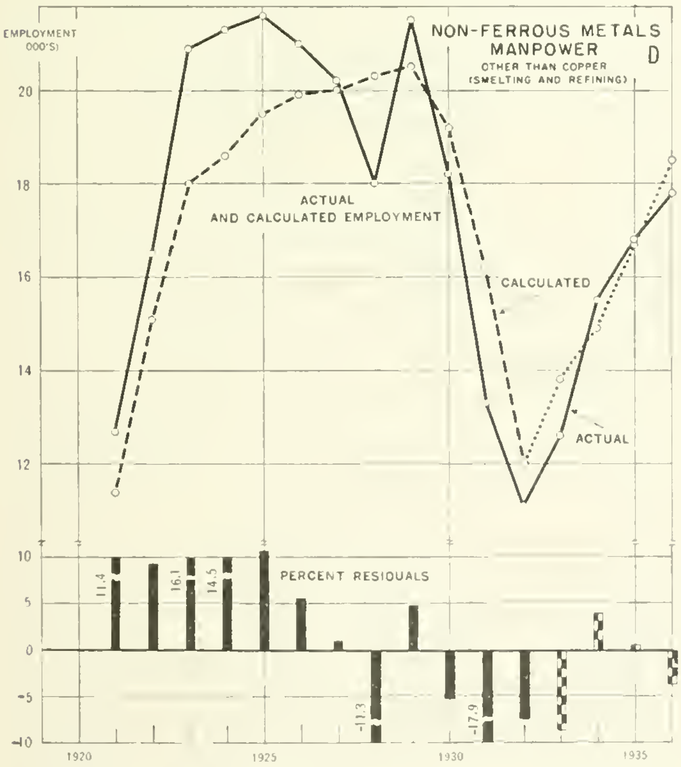

FIG 138a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 138a IN APPENDIX

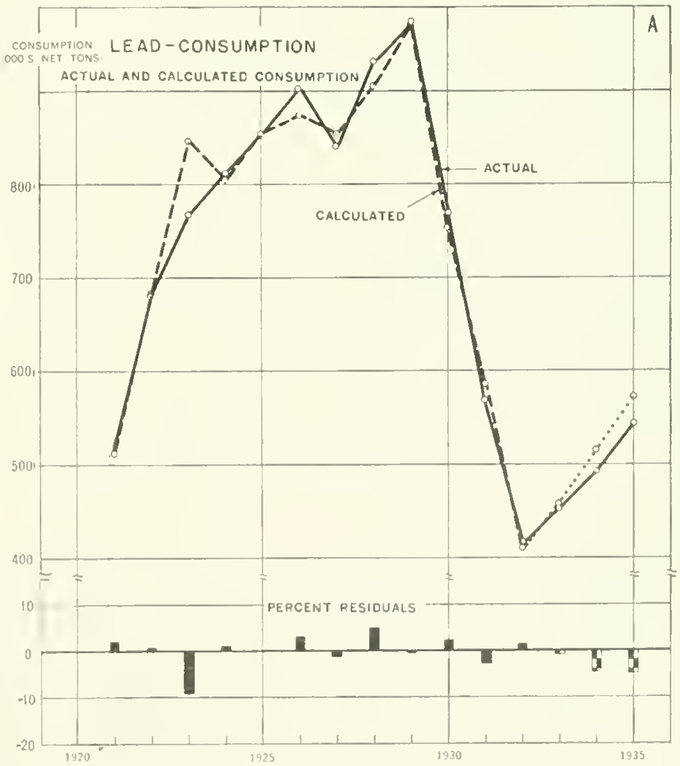

FIG 138b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES LEAD CONSUMPTION TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 138c IN APPENDIX

CHART XLVI

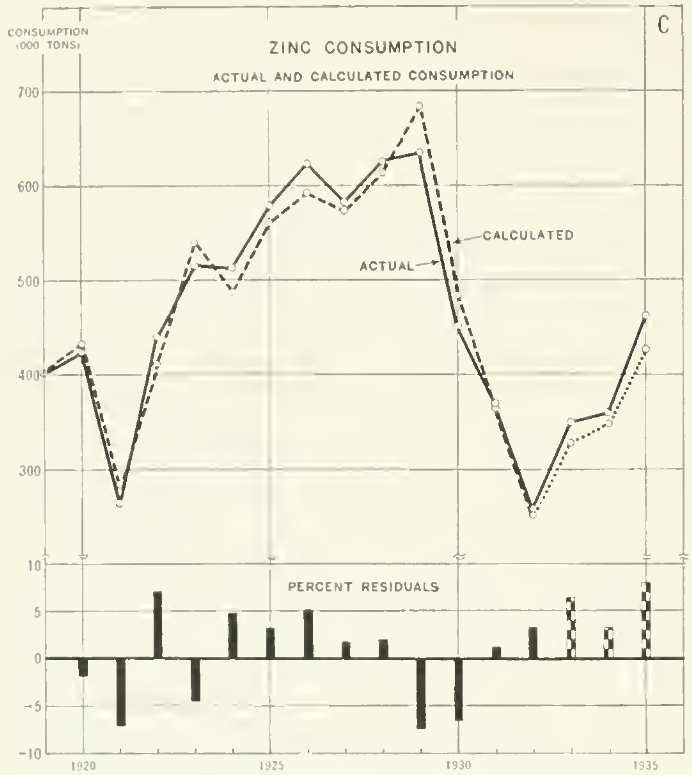

FIG 138c CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES ZINC CONSUMPTION TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 138c IN APPENDIX

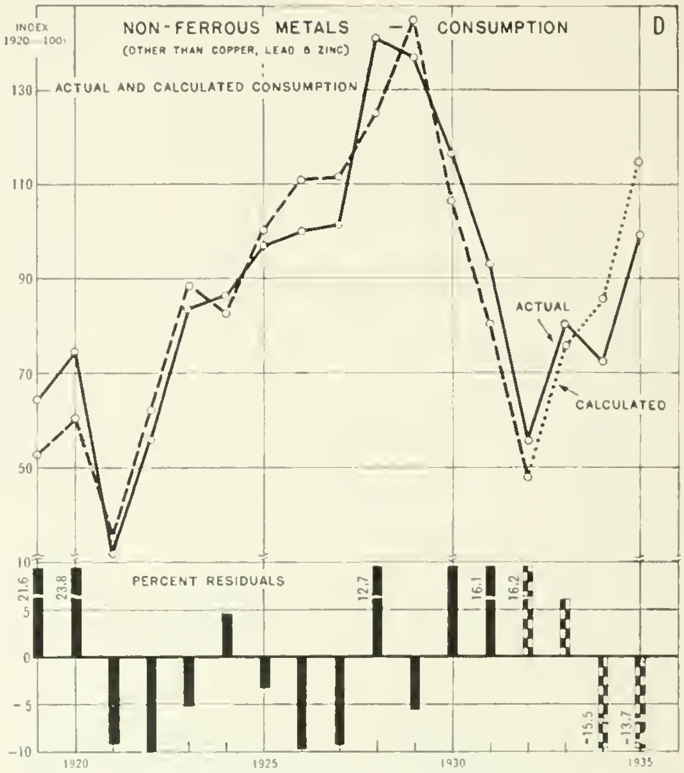

FIG 138d CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 138d IN APPENDIX

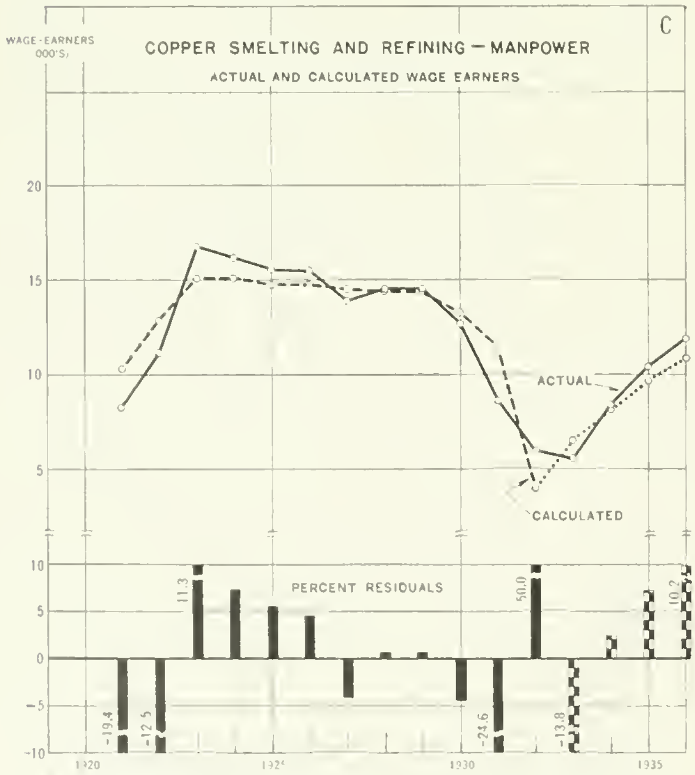

FIG 38 1a CALCULATED WAGE-EARNERS ARE BASED ON A FORMULA WHICH RELATES WAGE-EARNERS TO PRODUCTION OF REFINED COPPER AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 138 1a IN APPENDIX

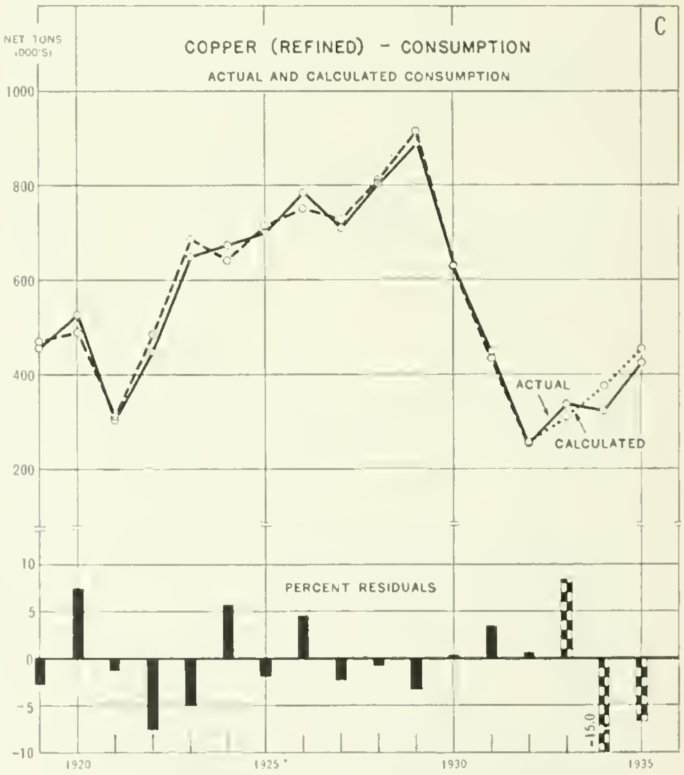

FIG 138 1b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDUSTRIAL PRODUCTION, CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 138 1b IN APPENDIX

CHART XLVII

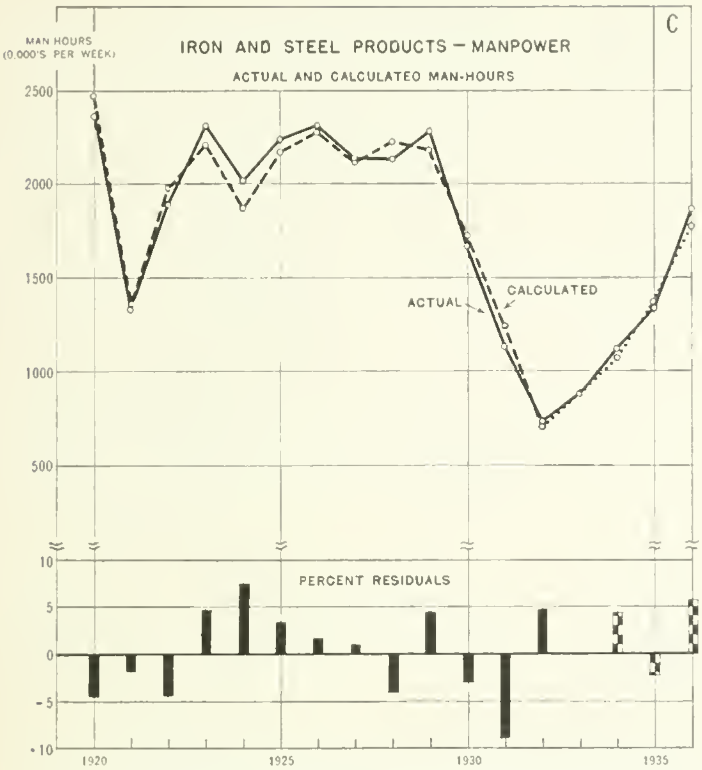

FIG 139 a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO DEFLATED VALUE OF OUTPUT AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 139a IN APPENDIX.

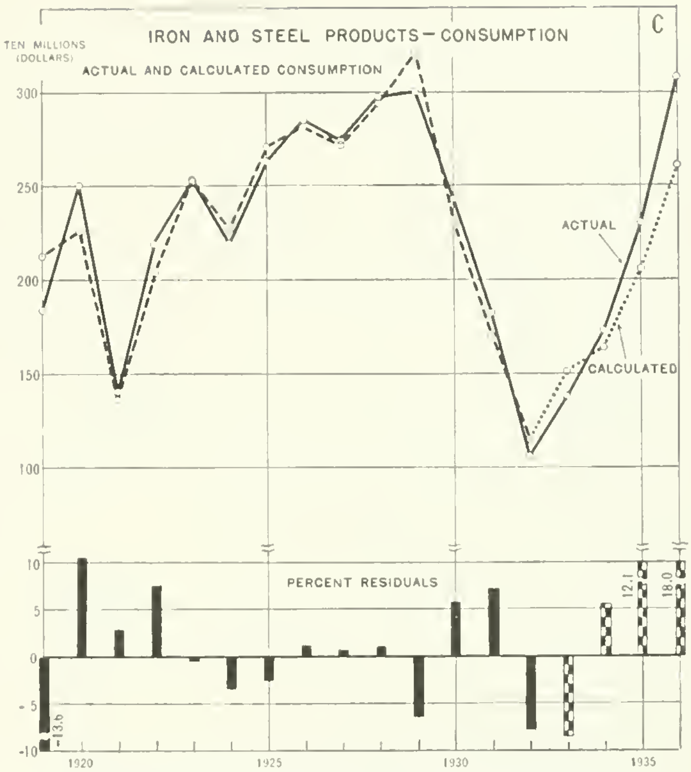

FIG 139 b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDUSTRIAL PRODUCTION, DEFLATED PRICE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 139b IN APPENDIX

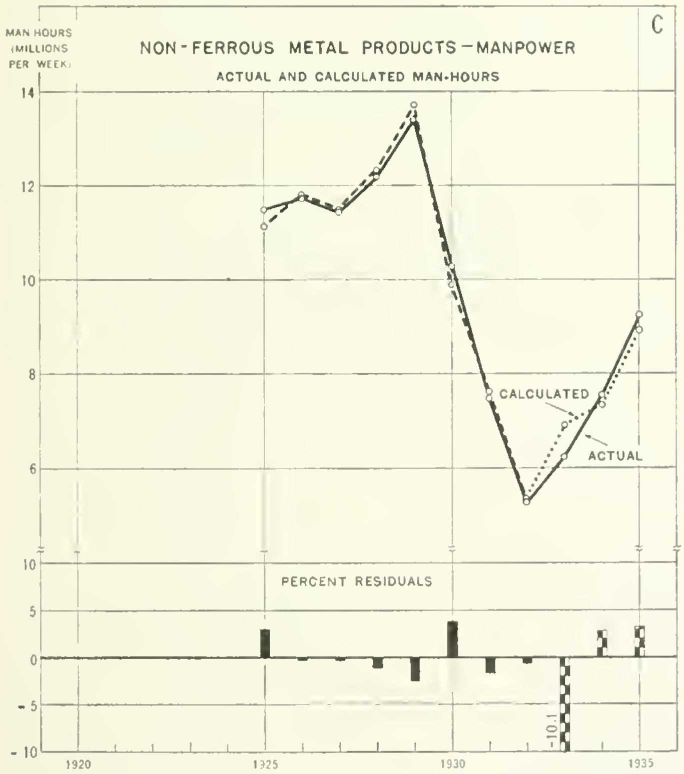

FIG 140 a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO INDUSTRIAL PRODUCTION. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 140a IN APPENDIX.

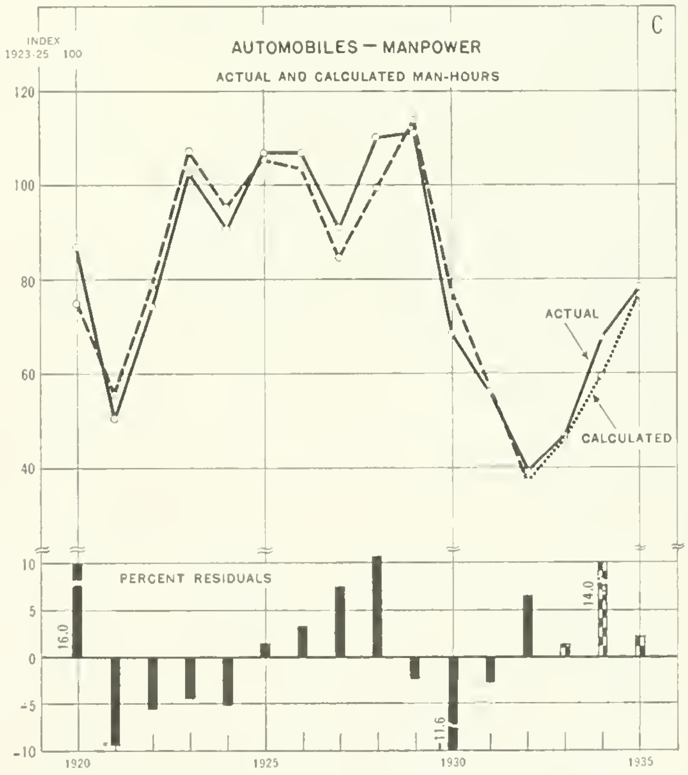

FIG 141 a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 141a IN APPENDIX.

CHART XLVIII

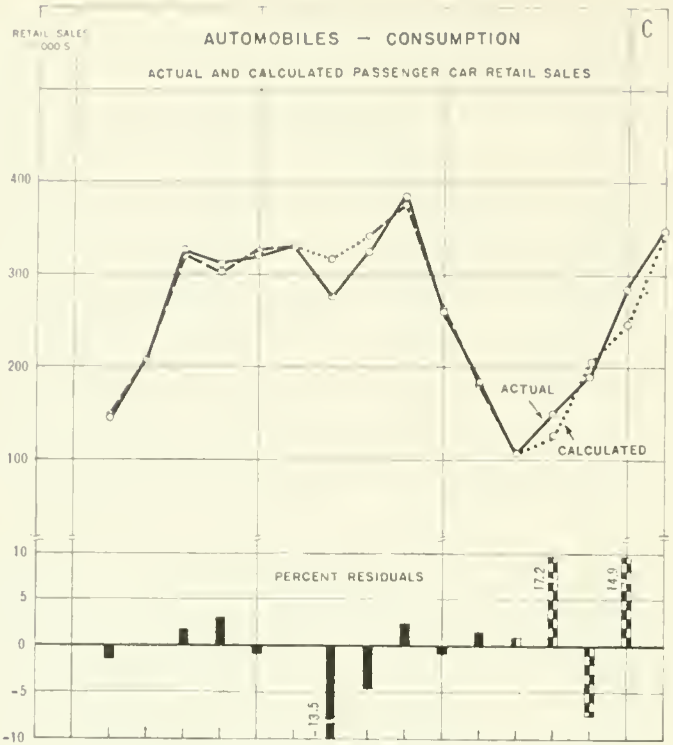

FIG. 141b CALCULATED PASSENGER CAR RETAIL SALES ARE BASED ON A FORMULA WHICH RELATES RETAIL SALES TO REAL INCOME OF WAGE-EARNERS, REAL INCOME OF OTHER THAN WAGE-EARNERS, CARS AT LEAST SEVEN YEARS OF AGE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 141b IN APPENDIX

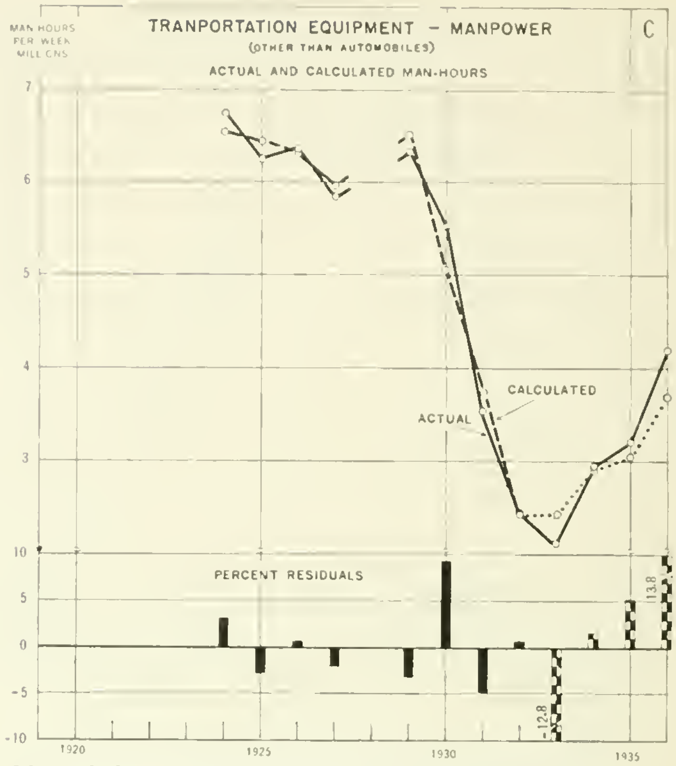

FIG 143a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 143a IN APPENDIX.

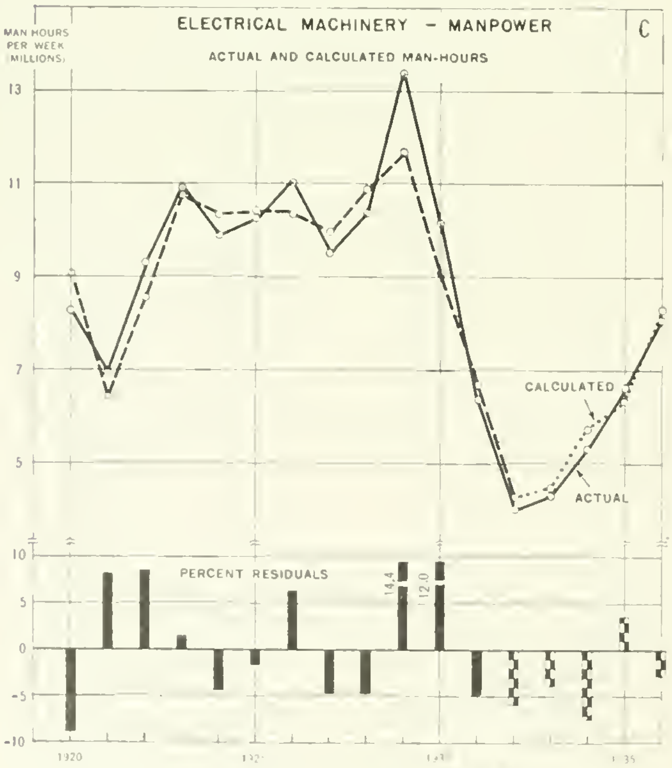

FIG. 144a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 144a IN APPENDIX.

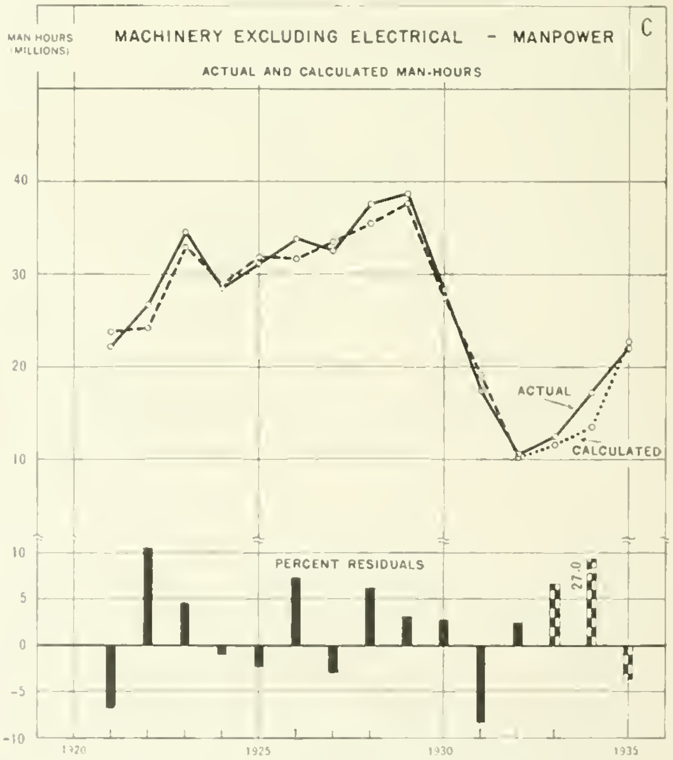

FIG 145a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO DEFLATED OUTPUT AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 145a IN APPENDIX

CHART XLIX

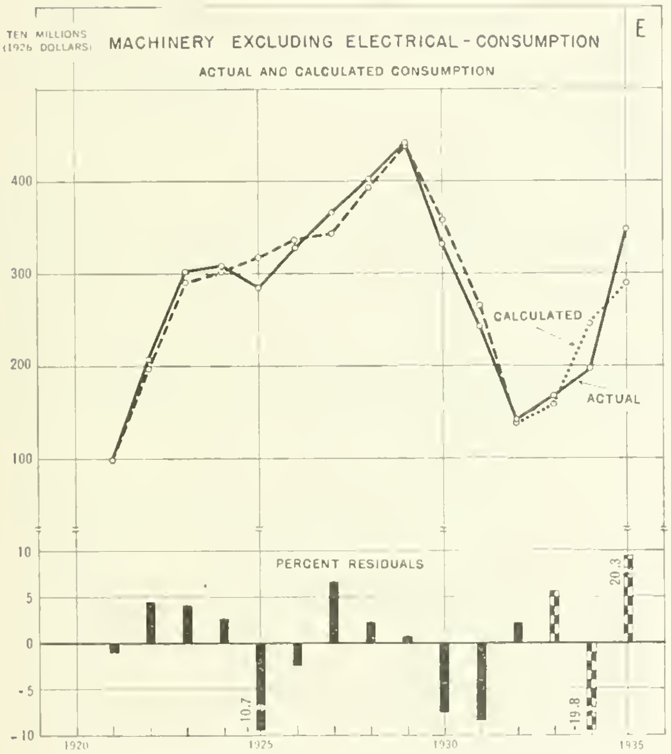

FIG 145 b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 145b IN APPENDIX

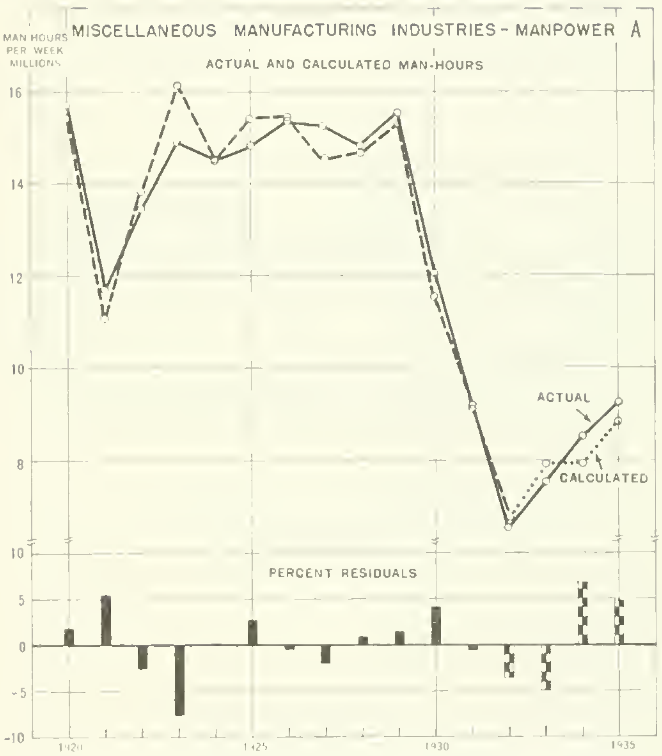

FIG 146 a CALCULATED MAN HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO INDUSTRIAL PRODUCTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 146a IN APPENDIX

CHART L

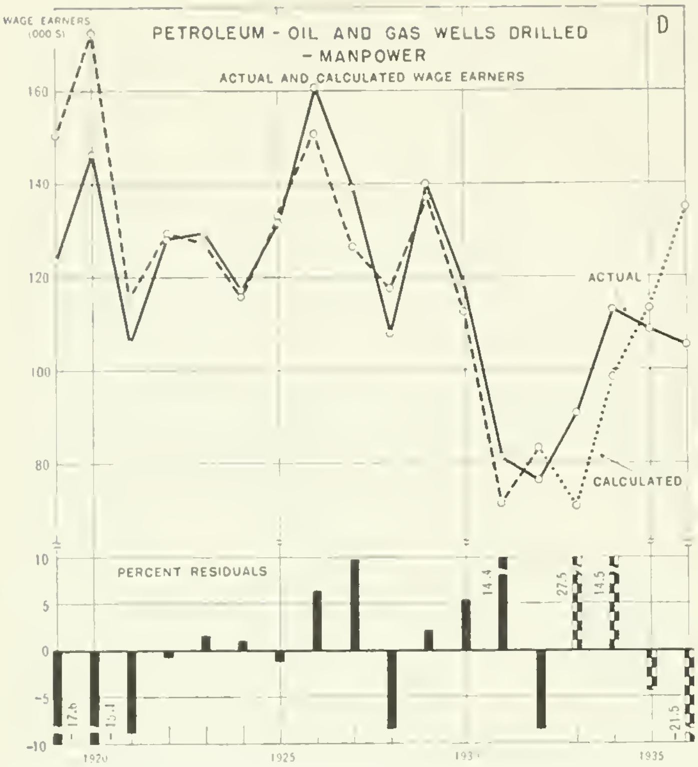

FIG 201a CALCULATED WAGE-EARNERS ARE BASED ON A FORMULA WHICH RELATES WAGE-EARNERS TO OIL AND GAS WELLS DRILLED AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 201a IN APPENDIX.

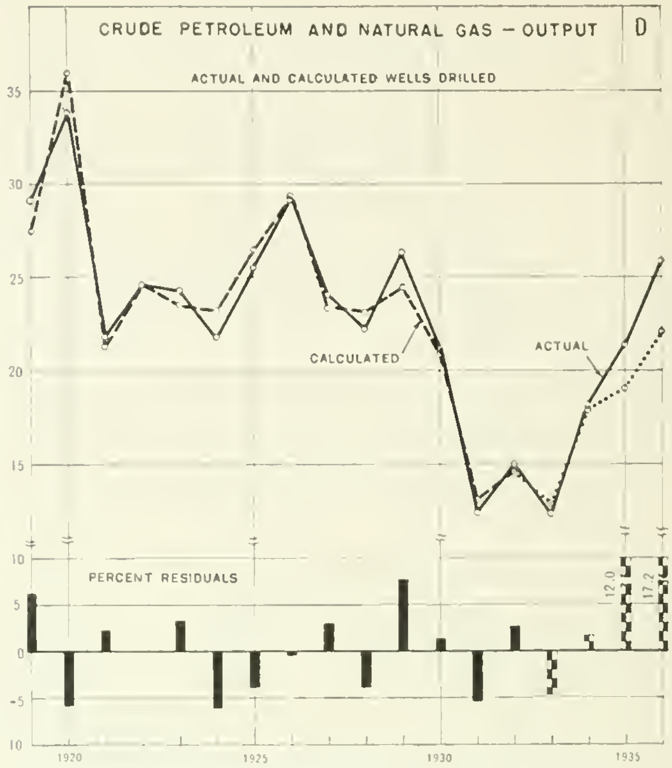

FIG 201b CALCULATED WELLS DRILLED IS BASED ON A FORMULA WHICH RELATES OIL AND GAS WELLS TO CRUDE PETROLEUM PRICES, INDUSTRIAL PRODUCTION, AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 201b IN APPENDIX

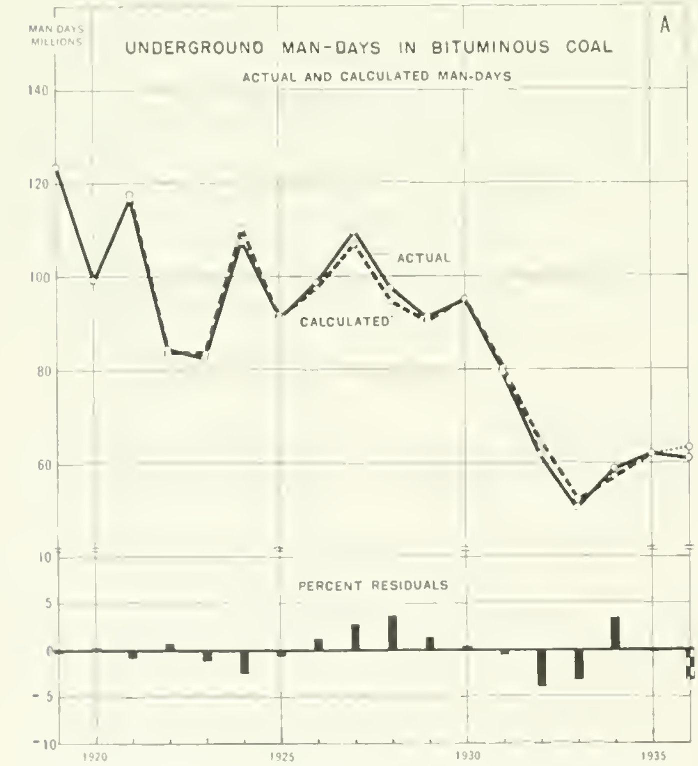

FIG. 202a CALCULATED MAN-DAYS ARE BASED ON A FORMULA WHICH RELATES MAN-DAYS THE UNDERGROUND BITUMINOUS COAL PRODUCTION, SIZE OF MINE AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 202a IN APPENDIX.

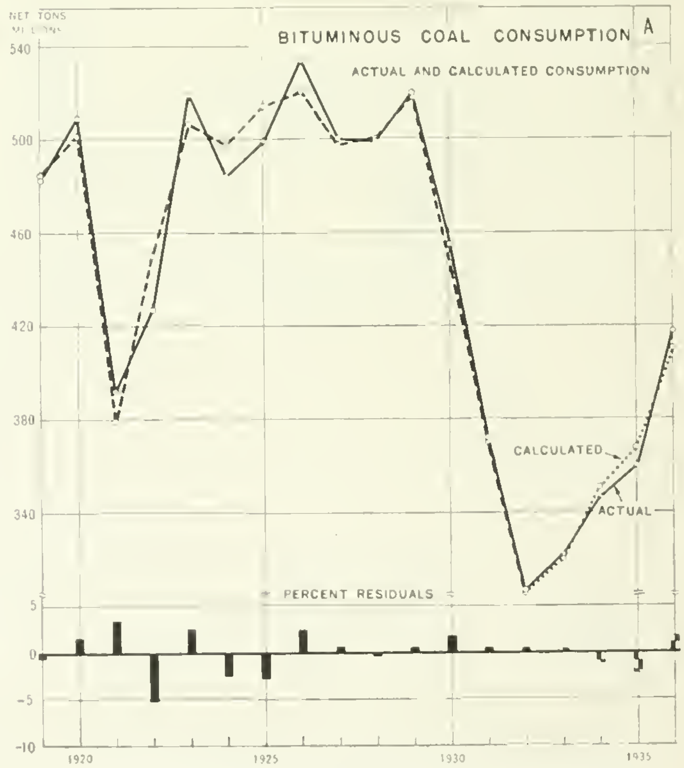

FIG. 202b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDUSTRIAL PRODUCTION, CONSUMER INCOME, RATIO OF COAL TO FUEL OIL PRICE, EFFICIENCY INDEX AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 202b IN APPENDIX.

CHART LI

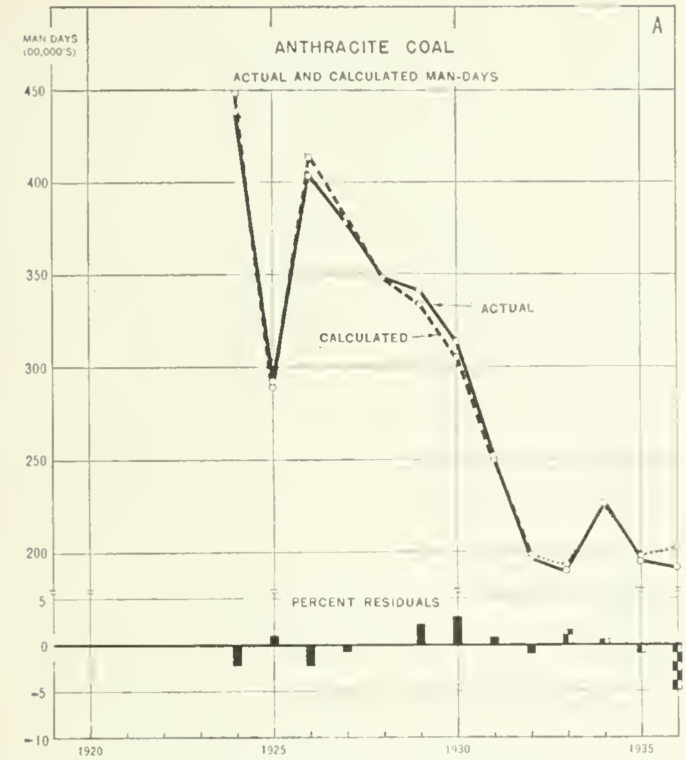

FIG. 203a CALCULATED MAN-DAYS ARE BASED ON A FORMULA WHICH RELATES MAN-DAYS TO ANTHRACITE COAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 203a IN APPENDIX.

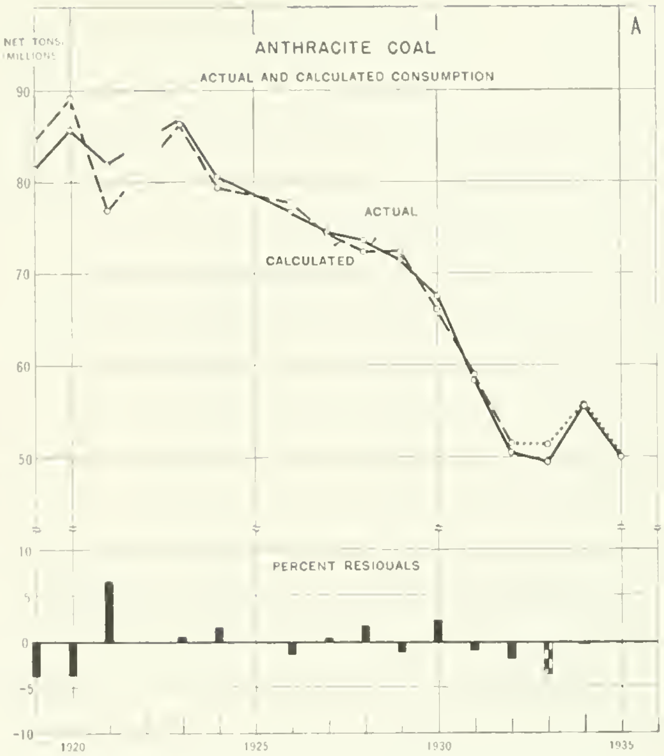

FIG. 203b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO CONSUMER INCOME, PRICE RATIO AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 203b IN APPENDIX.

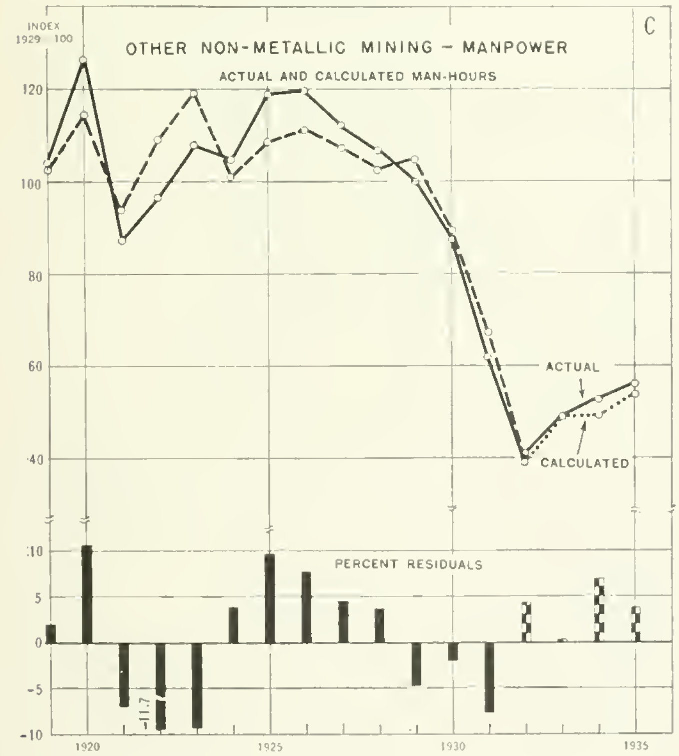

FIG. 204a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 204a IN APPENDIX.

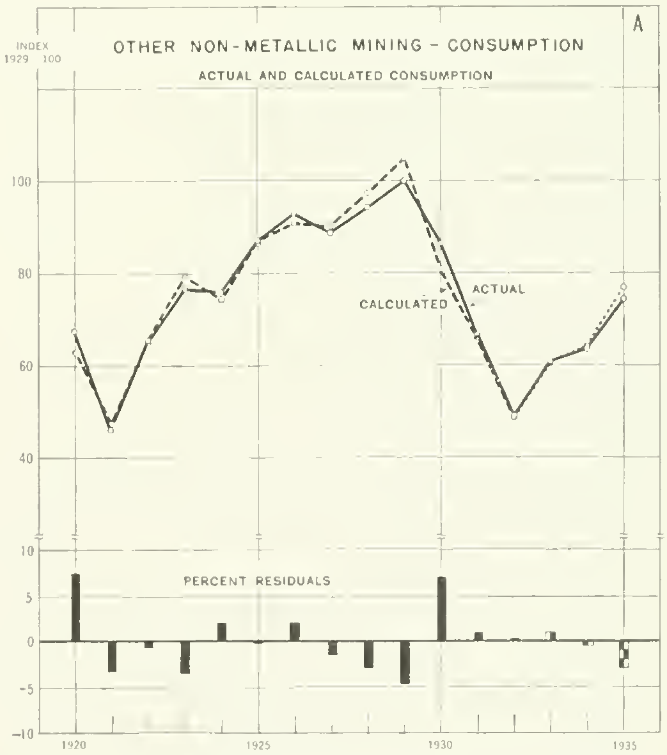

FIG. 204b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO INDUSTRIAL PRODUCTION, CONSTRUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 204b IN APPENDIX.

CHART LII

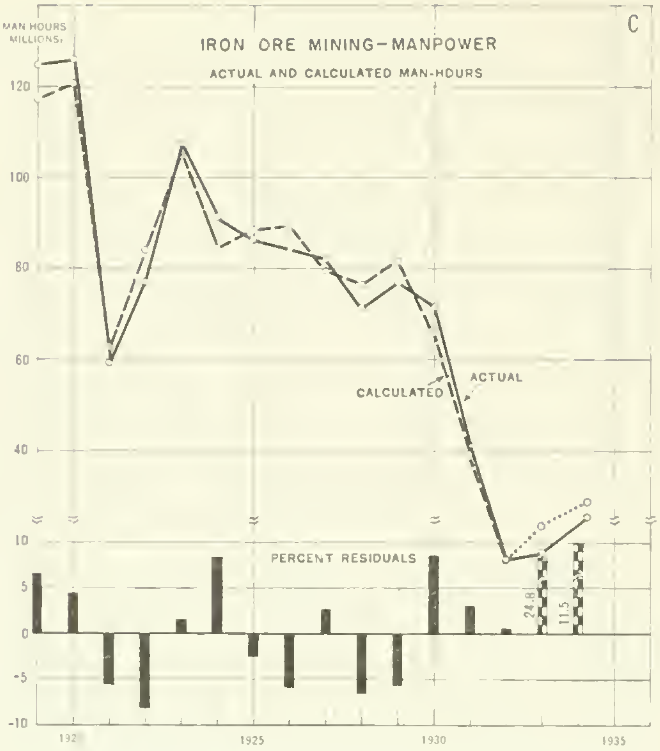

FIG 205a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 205 IN APPENDIX

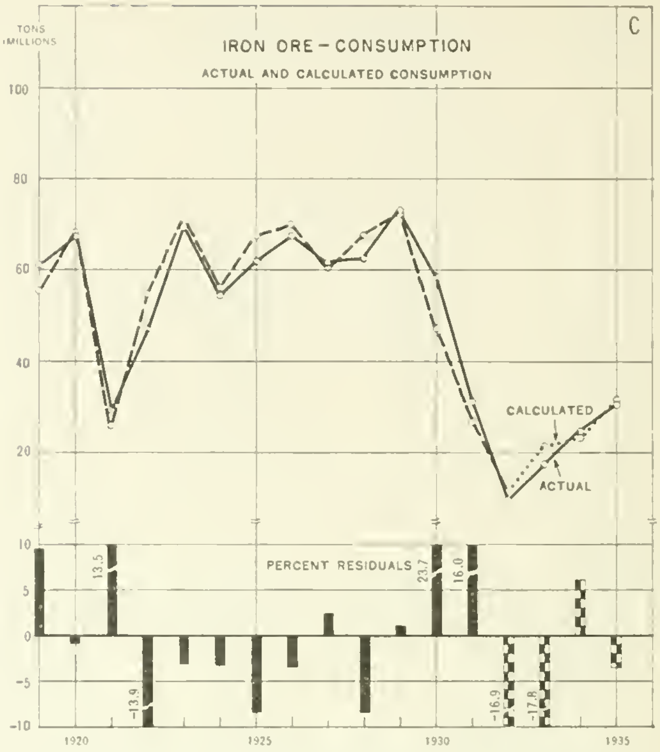

FIG 205b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO IRON AND STEEL AVAILABLE FOR DOMESTIC CONSUMPTION AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 205b IN APPENDIX

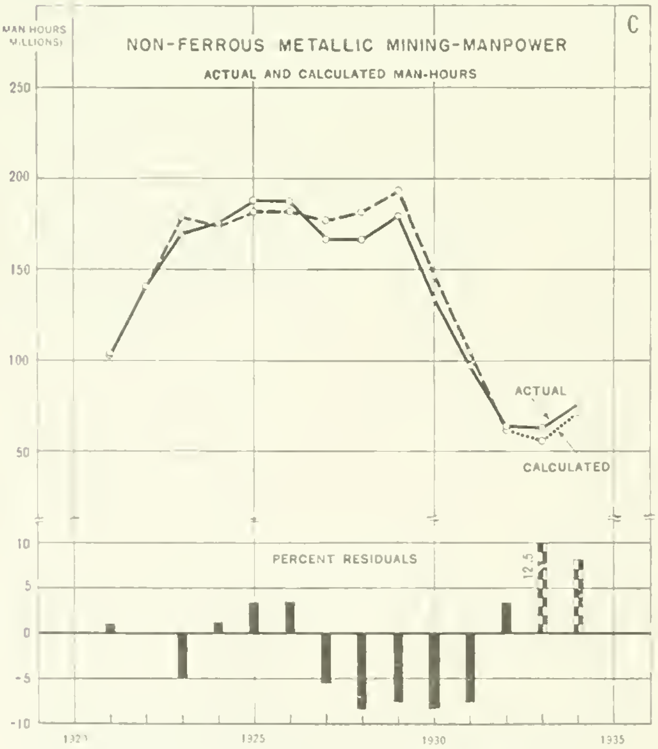

FIG 206a CALCULATED MAN-HOURS ARE BASED ON A FORMULA WHICH RELATES MAN-HOURS TO PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 206a IN APPENDIX

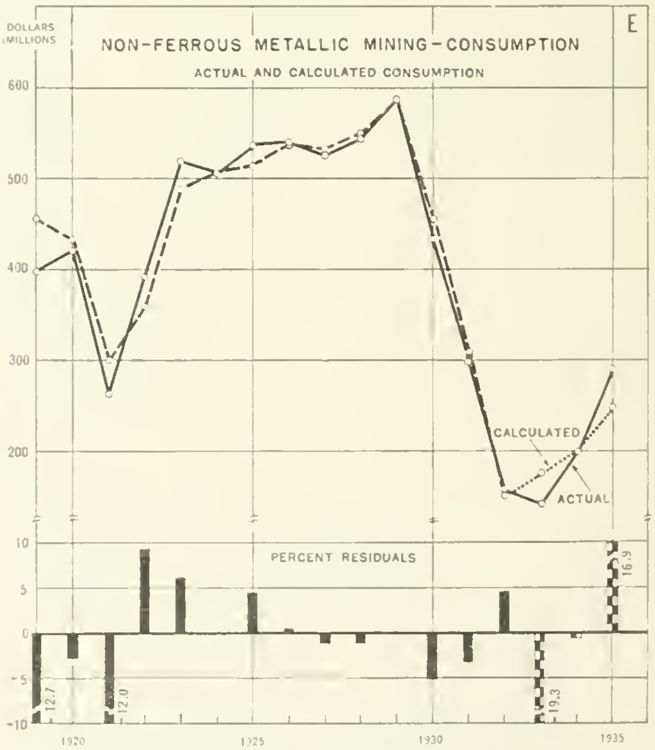

FIG 206b CALCULATED CONSUMPTION IS BASED ON A FORMULA WHICH RELATES CONSUMPTION TO REFINING OF NON-FERROUS METALS AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 206b IN APPENDIX

CHART LIII

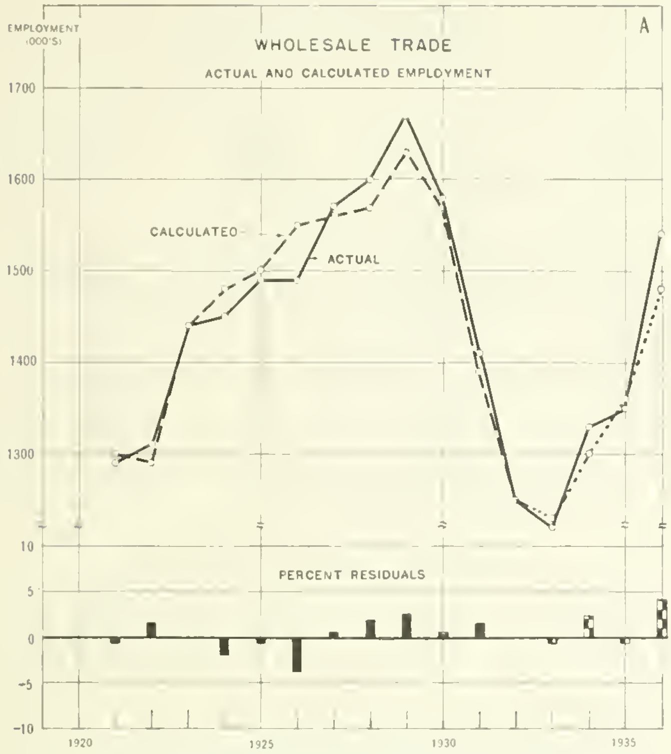

FIG 301a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO INDUSTRIAL PRODUCTION FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 301a IN APPENDIX

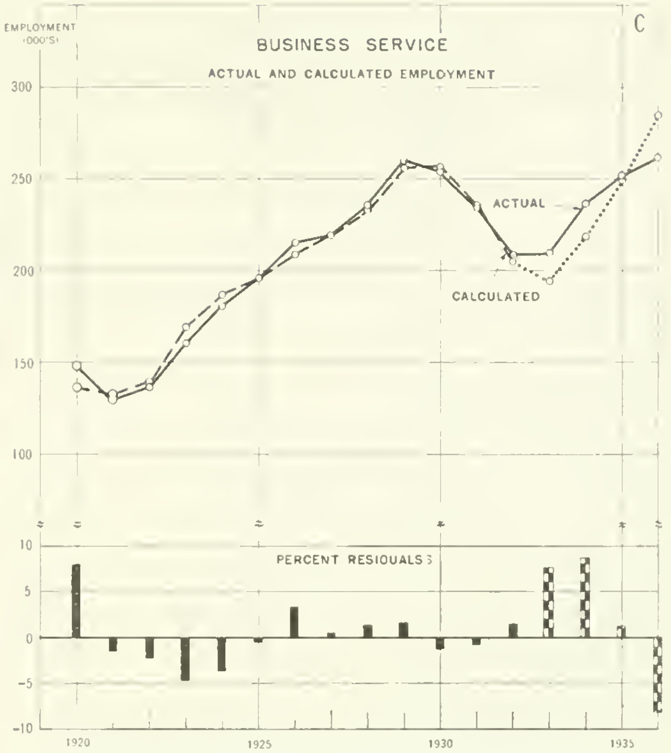

FIG 302a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 302a IN APPENDIX

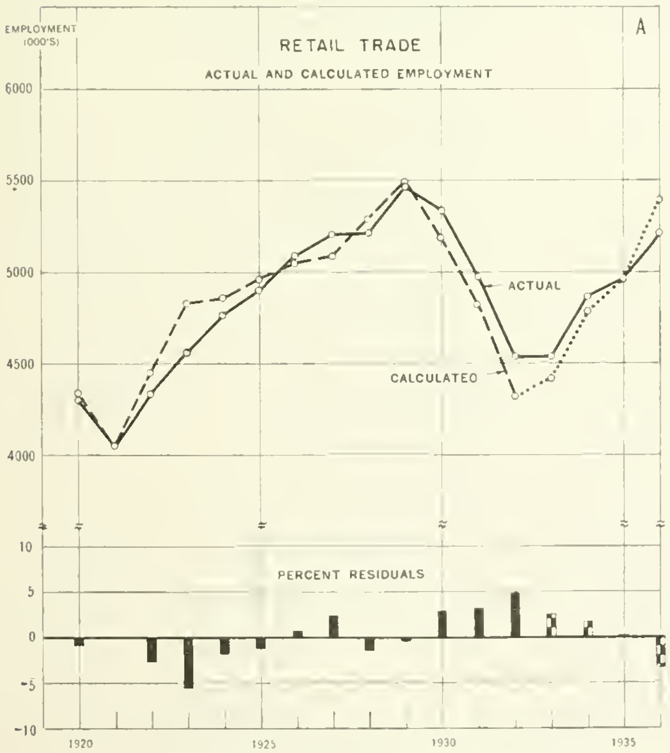

FIG 401a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 401a IN APPENDIX

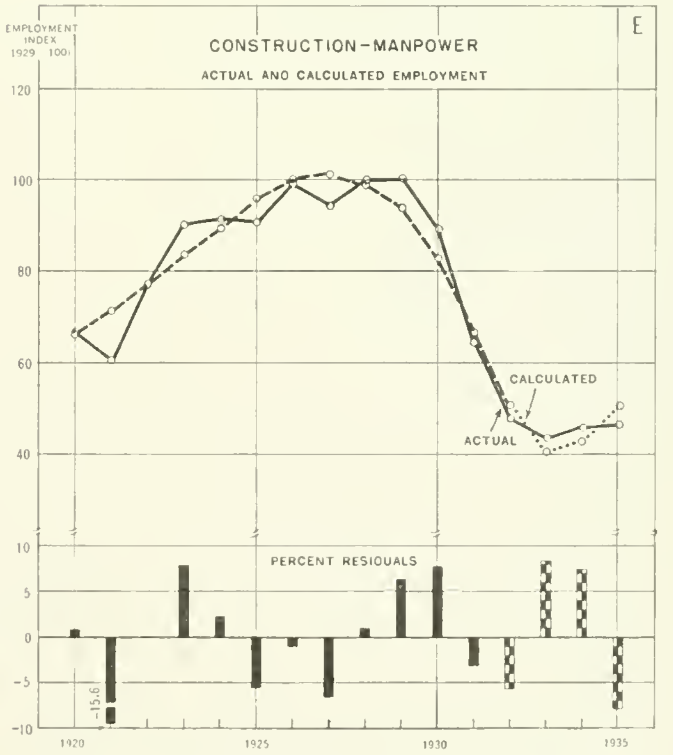

FIG 500a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO DEFLATED OUTPUT AND A TIME TREND FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 500a IN APPENDIX

CHART LIV

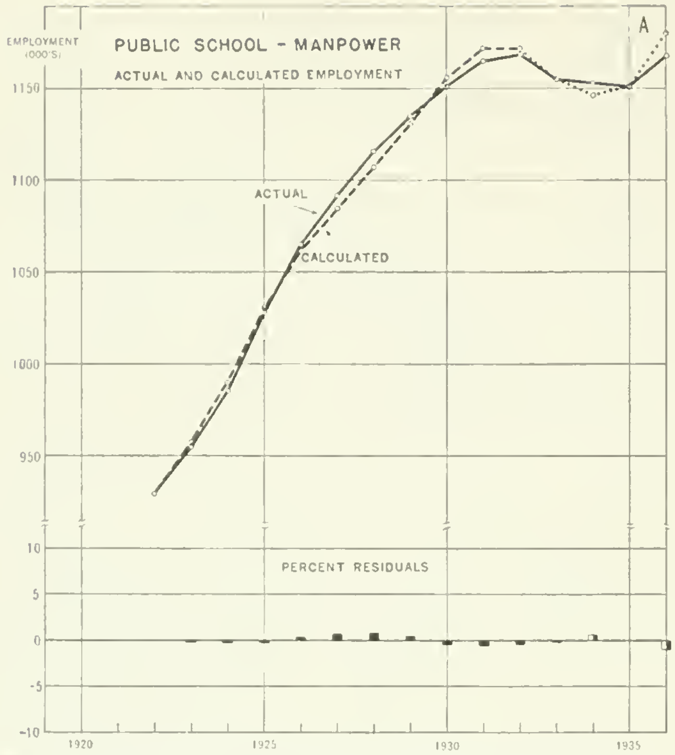

FIG. 601a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 601a IN APPENDIX.

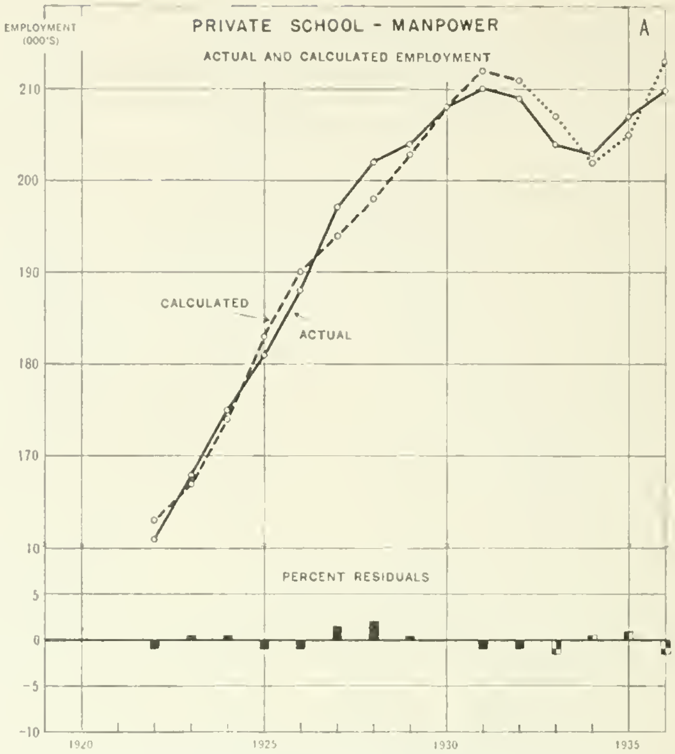

FIG 602a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 602a IN APPENDIX.

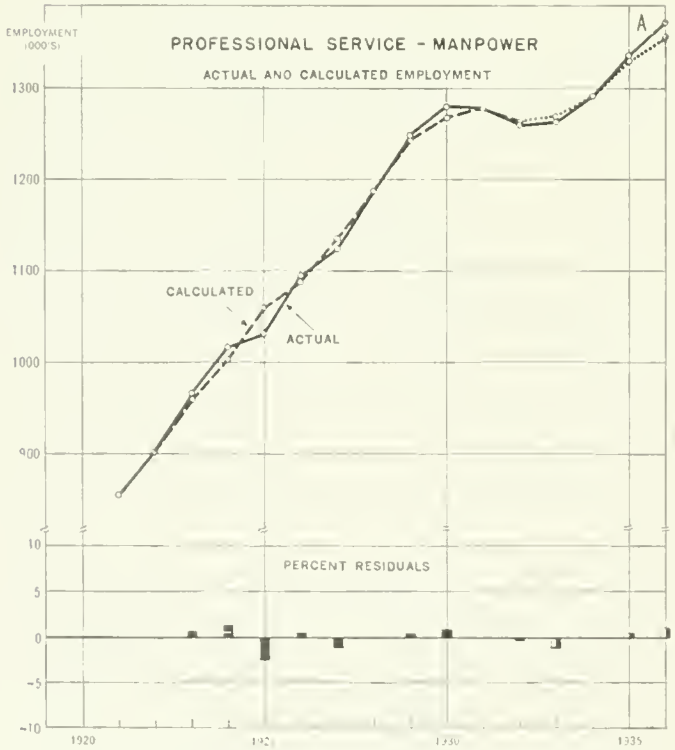

FIG. 603a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME, POPULATION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 603a IN APPENDIX.

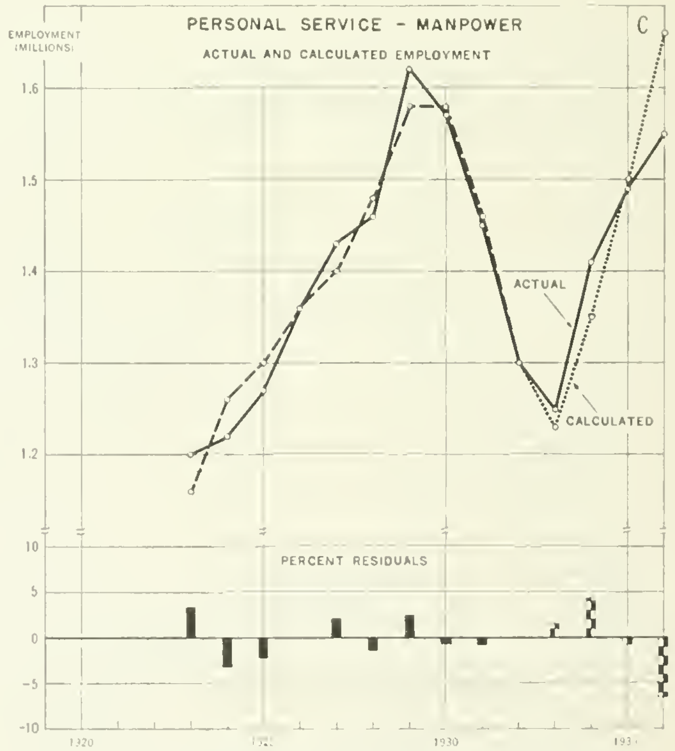

FIG 604a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME, AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 604a IN APPENDIX.

CHART LV

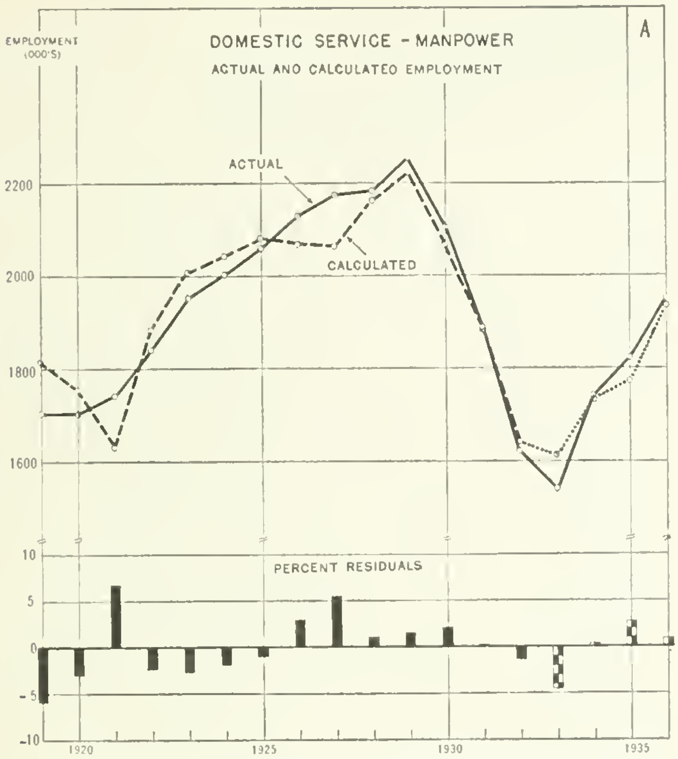

FIG 605a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME (NON-WAGE-EARNER) AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 605a IN APPENDIX

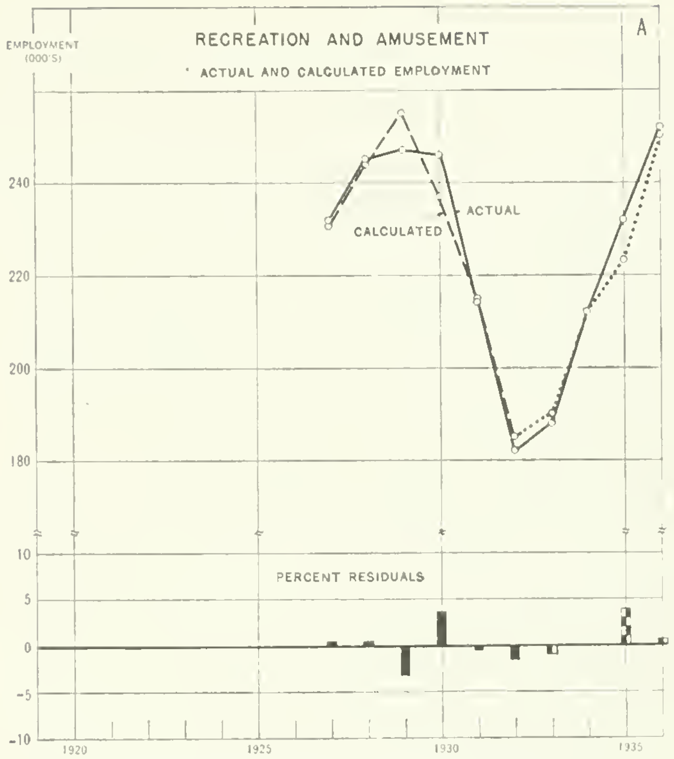

FIG. 606a CALCULATED MANPOWER IS BASED ON A FORMULA WHICH RELATES MANPOWER TO CONSUMER INCOME FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 606a IN APPENDIX.

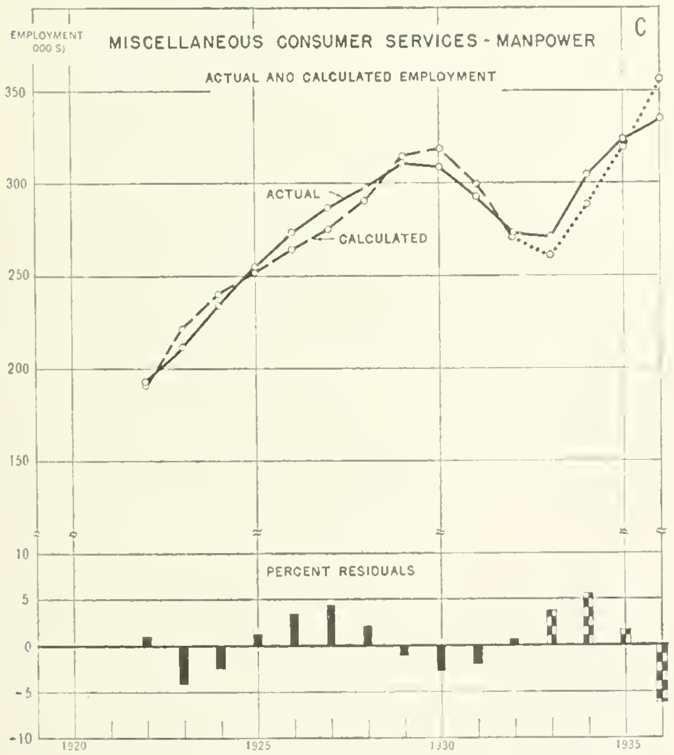

FIG 607a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO CONSUMER INCOME AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO 607a IN APPENDIX

CHART LVI

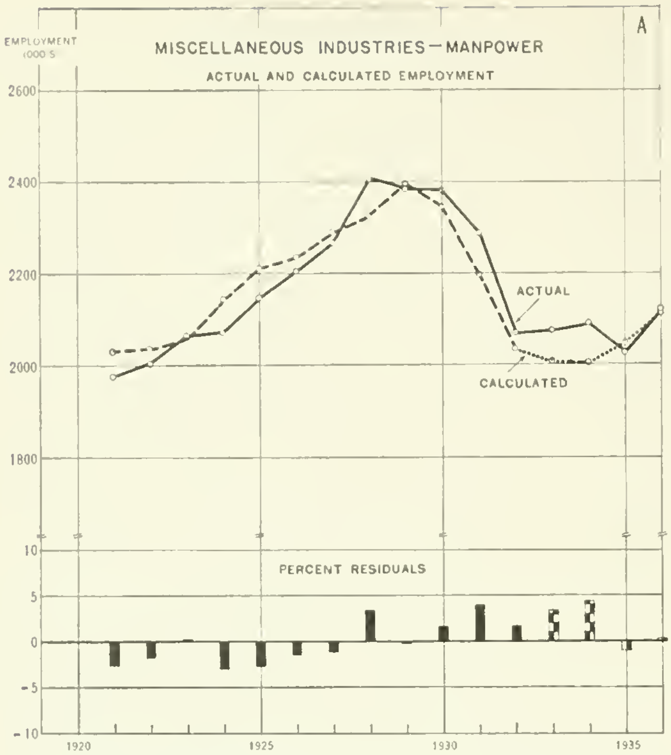

FIG. 800a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 800a IN APPENDIX.

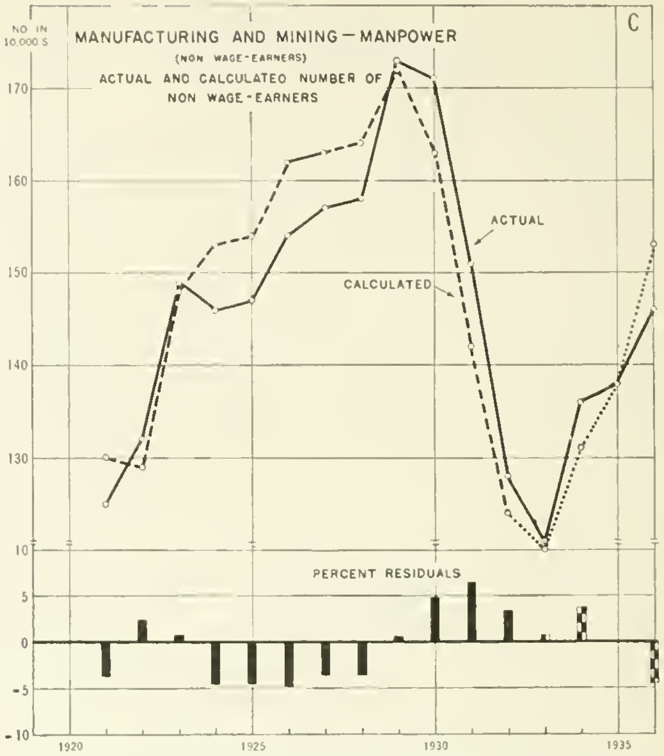

FIG 801a CALCULATED EMPLOYMENT IS BASED ON A FORMULA WHICH RELATES EMPLOYMENT TO INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 801a IN APPENDIX.

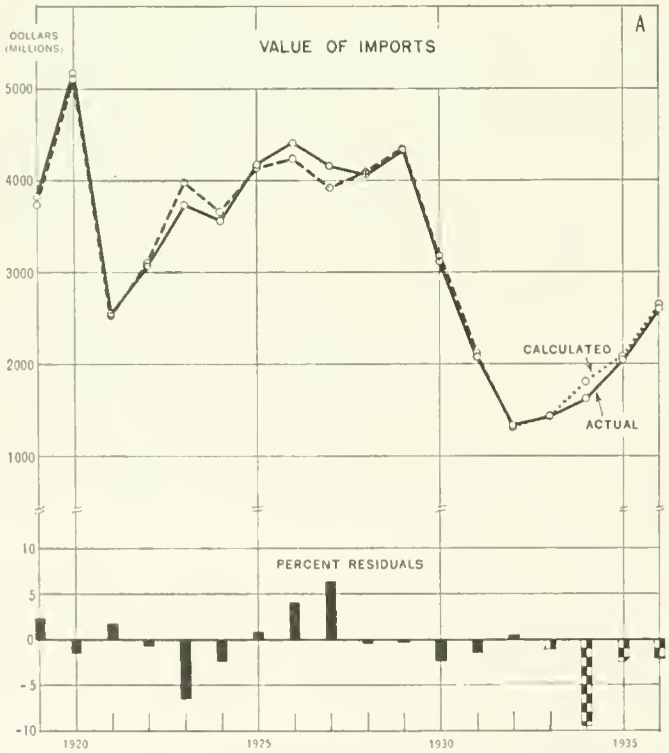

FIG 1000 CALCULATED VALUE OF IMPORTS IS BASED ON A FORMULA WHICH RELATES VALUE OF IMPORTS TO CONSUMER INCOME, VALUE OF INDUSTRIAL PRODUCTION AND A TIME TREND. FOR THE FACTUAL DATA AND METHOD USED SEE SUMMARY NO. 1000 IN APPENDIX.

APPENDIX 1
METHODOLOGY

I. Introduction

The purpose of this appendix is to describe the technical procedure used for deriving relationships and constructing patterns of resource use as outlined in the text, and to give summary descriptions of the principal relationships worked out.

The principal stages in pattern construction can be briefly enumerated as follows: First, segmentation—division of the whole economy into adequate segments; second, analysis of segments—derivation of the underlying economic relationships characterizing each segment and embodying them in statistical formulas; and third, construction of patterns of resource use—selection of assumptions as the basis for particular patterns of resource use and the calculation of the conversion activities of all segments proper to these assumptions.

This appendix covers each of these three stages. Section II discusses segmentation and section III to VII take up methods of discovering relationships, consumption relationships connecting each segment with factors in its economic environment, and conversion relationships connecting input and output within the segment. Section VIII deals with pattern construction—assembling the figures for individual segments into an integrated pattern for the whole economy.

II. Segmentation

The first step towards building patterns of resource use is to divide up the whole economy into industries or industrial segments which can be analyzed separately for the purpose of discovering underlying economic relationships. The aim of segmentation is not only to present detail that is more useful than a general aggregate, but to obtain segments whose underlying relationships can be stated in reasonably simple terms. This section will examine the considerations which should govern this division into segments and then present the segmentation scheme used in this study.

A. Considerations Governing Segmentation

In dividing up the whole economy into separate segments the three major considerations are: (1) That each segment be as homogeneous in function as possible; (2) that the number of separate segments be kept as low as possible; and (3) that existing classifications be followed so far as possible. These three considerations tend to be in conflict and a balance among them must be worked out.

1. *Selecting homogeneous segments.* All activity in a single segment must be capable of being treated as homogeneous. From the standpoint of the objectives of this study homogeneity of segments has reference chiefly to economic homogeneity, viz, having similar economic characteristics. Thus activity producing ultimate consumption goods and that producing capital goods should be kept separate as far as possible. So also should the production of necessities and of luxury goods. Likewise productive activity involving highly flexible prices or price margins should be differentiated from activity involving inflexible prices or inflexible price margins. Similarly, the production of commodities with an elastic demand and of those with inelastic demand require separate treatment, as do expanding industries in contrast to contracting industries. Finally the character of the services rendered or commodities produced and the techniques employed give a basis for subdivision. The above differences form the most fundamental basis for division into segments. The expectation is that by having within one segment only activities which are similar, the problem of analysis will be simplified and the results will be more reliable.

"Similar" and "homogeneous" are relative words. All shoemaking could be lumped together and treated as a single function. Or the making of men's shoes could be treated as a single segment while women's shoes could involve a second segment and children's shoes, a third. Similarly, bituminous coal could constitute a single segment or it could be divided into two segments, one for open-pit mining and one for underground mining. Wherever separate activities can be described in terms of a common function, however broad or however narrow, those activities can be grouped together within a single segment.

As economic activity is divided into a larger and larger number of segments, it is possible to make each segment more nearly homogeneous. Agriculture could constitute one segment, manufacturing another, and distribution a third. Or each of these could be subdivided, giving such segments as wheat raising, cotton raising, shoemaking, textile manufacture, and grocery distribution. Each of these in turn could be further divided. Wheat raising could be broken into soft-wheat raising, hard-wheat raising, etc. Textile manufacture could be split according to the different fibers used and according to different steps in the process of manufacture—carding, spinning, weaving, finishing.

The number of segments into which industry could be subdivided is limited only by the number of separate functions into which economic activity itself can be divided, and the greater the subdivision the more homogeneous it is possible to make the separate segments.

Historically a variety of criteria, having bearing on economic homogeneity, have been employed in dividing all economic activity into separate functions and separate segments. Activities have sometimes been treated as involving a common function if they make use of a common raw material—the manufacture of "leather products other than shoes" could be taken as a common function. Technologically different activities have sometimes been grouped if they produce a common product, as for instance the coke or rayon industries. Or sometimes separate activities may be grouped because their products are capable of performing the same function, for example, the clothing industry. Or grouping may be based on the use of a common process—byproduct coke in contrast to beehive coke manufacture or on the type of change affected, chemical as against other form of change. Other groupings are possible, such as grouping by the nature of the organization, whether individual, partnership, corporation, or government or grouping by the characteristics of the product whether perishable or durable. More often a combination of criteria is employed as in the case of the cotton-textile industry and the meat-packing industry where the raw material and the process both enter into the definition, or the metal furniture industry where both the raw material and the function of the product enter.

For the present purpose, no single criterion of division into segments can be adopted except the general criterion that segments are most homogeneous when substantially the same raw materials are used, substantially the same products are obtained, and substantially the same process is employed in converting one into the other.

While all of these desiderata should be kept in mind in segmenting industry, the practical problems introduced by existing statistical classifications of data and the difficulties of collecting data are such that any working segmentation is likely to depart widely from the criteria just indicated and a high degree of homogeneity in segments is not likely to be attained.

2. *Keeping down the number of segments.*—In direct conflict with the effort to get a high degree of homogeneity in individual segments is the necessity of keeping the number of segments within reasonable bounds. While increasing the number of segments allows the individual segments to be made more homogeneous, after a certain point, it makes the analysis more difficult. This arises from three causes. First, an increase in the number of segments increases the analytical work in proportion. Second, as the number of segments mounts, the job of constructing patterns of resource use becomes more complex. Third, the analysis of segments resulting from a minute subdivision of industry is more difficult because the factors relating a small segment to the rest of the economy are less likely to be basic to the economy as a whole, such as consumer buying power, and price level, and are more apt to be of a less predictable sort such as the degree of sales promotion, style and quality factors, and popular fancy. Thus, while women's clothing as a whole may be treated fairly satisfactorily as a single segment, the results of statistical treatment of a single subdivision such as women's tailor-made suits are likely to be unsatisfactory and unreliable.

Thus, even if the statistical material could be obtained to make possible a high degree of subdivision into separate segments, both theoretical and practical objections arise and a balance has to be worked out between the advantages of greater homogeneity that go with a larger number of segments and the advantages of convenience, simplicity, and reliability which go with a smaller number of segments.

3. *The limitations on segmentation due to available data.*—So far as the immediate future is concerned, the dominant factor in determining the lines of division into segments is necessarily the available data and the classifications employed by agencies now collecting statistical material. While it is possible to combine the data for classifications now employed, it is difficult if not impossible to take existing data and rework it in terms of an entirely different classification.

The problem of working out the best segmentation in the light of the need for homogeneity, the need for limiting the number of segments, and limits of existing data is necessarily a matter of compromise and trial and error. Experience with the analysis of the relationships involved in particular segments should indicate ways of improving any initial segmentation that may be adopted. It may turn out that some segments can advantageously be combined while others should be split up. Only actual experience can indicate the most effective division.

B. A Provisional Division of the American Economy into Segments

As a first step toward the segmentation of all industry, the division indicated in chart XV was adopted. The relative importance of each division (measured by the number of man-years of activity in 1935) is indicated by the area blacked in.

This chart gives an initial panorama of productive activity in the American economy. The general flow of materials runs from the top to the bottom of the chart, though many minor flows such as the back-flow of manufactured goods to be used in agriculture and mining run in the opposite direction. Most raw materials originate in agriculture, in mining, and in imports from abroad (not shown). The great bulk of raw materials then goes to manufacturing. The items leaving the manufacturing segment go for the most part to consumption (through trade), to construction, or to exports (also not shown). At the left of the chart are the service industries including government, public utilities, and services to the consumer.

While this division of the economy into 11 segments represents an appropriate first step in segmentation, the economy needs to be divided into a larger number of segments than are shown in this first diagram if useful patterns of resource use are to be developed. Chart XVI shows the division into 81 segments used in the present study. The agricultural segment of chart XV has been kept intact but minerals has been split into 5 segments, manufacturing into 50 segments, and so forth. Most of the splitting has been done in the manufacturing area and the manufacturing segments have been arranged in three lines representing, roughly, successive steps of processing. Some materials go through only one processing, e. g., most dairy products, and thereafter move directly to the consumption area via the distribution segments. Others go through as many as three processings, for example, cloth made in the cotton textile segment may go to the finishing segment and from there to the "wearing apparel made from purchased fabrics" segment.

As a general rule the segmentation used by the Department of Commerce in its national income studies has been followed. Experience showed, though, that it was advisable to combine certain of the industries reported separately in the national income estimates. For example, retail trade was treated as one segment in calculating employment because statistics covering the several desired segments are, in general, not available. Likewise, agriculture had to be treated as a single segment for the same reason.

The figures shown in chart XV are in terms of equivalent full-time employment for all persons engaged in each of the 11 segments. The figures in chart XVI are also given in terms of equivalent full-time employment. In the manufacturing and mining segments, only wage earners are indicated, and nonwage earners have been set up as a separate segment.

Central administrative office employees in manufacturing are reported by the 1929 census only in total, and the 1935 figure had to be calculated on the basis of the ratio of salaried employees for the 2 years. There is no way of allocating them to their proper segments except by some arbitrary proration formula. In order to avoid this, central office employees in manufacturing and mining were included in the segment covering nonwage earners in manufacturing and mining.

The final segments used in this study are defined in the summaries which appear in Appendix 2.

III. Selecting the Factors and Developing a Working Hypothesis as to Their Relationship

Once the whole economy has been divided into segments, the next stage in the process is to analyze each segment separately so as to discover, insofar as possible, its most important economic operating characteristics, and embody these in formulae representing the relationships between them. Several steps or phases of the analysis may be distinguished, the first two of which will be considered in this section.

The first step is to decide on the input and output items of significance to the segment and give them as precise a definition as possible. Thus, for the bituminous coal industry only one item of output, coal, is significant, while the main item of input, overshadowing all others, is manpower.

The second step is to select the factors whose variation is regarded as likely to be related significantly to the variation in the input or output items and to develop a working hypothesis as to their relation.

The third step is to bring together, adjust, and organize the data representing the selected factors for the period to be considered (section IV).

The fourth step is to test the hypothesis developed above as to how these factors are interrelated by the use of correlation analysis, first by graphical analysis, and second by numerical analysis which fits a formula to the data according to standard correlation techniques (section V).

The final step is to revise and improve the hypothesis in the light of the results obtained. This involves a repetition of the steps indicated above but with the fresh background of the results obtained and any new knowledge that can be brought to bear on the problem.

While the procedure to be followed in the analysis of segments can be set forth in the above five separate steps, in practice the five steps tend to be intermingled so that more than one step is carried on simultaneously. They are separated here because each involves its own special set of problems which will be analyzed below.

A. Determining and Measuring the Items of Input and Output

In deciding on the items of input and output for a particular segment and giving them precise definition, three main problems arise: First, what are the significant items of input and output; second, at what points in the economic process should they be measured; and third, in what units should they be measured.

The items of input and output which belong with a particular segment are determined in the process of dividing up the whole economy into segments. Thus, if the shoe industry is chosen as a single segment, shoes, slippers, scrap leather, waste, and other items constitute the output while manpower, leather, shoe findings, use of shoe machinery, repair parts, electric power, coal, oil, grease, and a host of other items constitute the input items.

It is necessary to deal only with the significant items of input and output for purposes of segment analysis. An item is significant for the purpose in hand only if it constitutes the initial use of ultimate resources—manpower, use of capital equipment, natural resources—or else is an output item of some other segment, and if it constitutes a major part of the value of the total input for the segment being analyzed. Thus, shoe findings, repair parts, oil, grease, etc., are presumably not significant input items in the shoe industry. Likewise, the only significant items of output are those which constitute a major part of the value of the total output for the segment. Scrap leather, waste, etc., are presumably not significant output items. The degree of refinement to which the analysis is being carried will, in large measure, determine whether or not a particular item is said to constitute a major part of the value of the total input or output of a segment.

Once the significant items have been decided upon, the next problem is to decide on the exact point in the economic process at which they should be measured. In dealing with the cotton textile segment, is it preferable to measure cotton cloth output as the cloth comes off the looms or as it is shipped by the manufacturers or as it comes from the textile finishers? Each of these would be a valid point of measurement, yet in most cases each would give a different figure. The exact point of measurement for an item of input or output must be largely determined on the one hand by the point at which the best statistical series are available and on the other hand by the point at which it is most desirable to draw the segmental lines in order to give the maximum degree of homogeneity to each segment.

With the items of input and output decided upon and the point of measurement determined, the next step is to determine the unit of measurement. Two different types of unit could be used, a physical unit, or a deflated value unit.

Of these two possibilities, the first is usually the most satisfactory, pounds or yards or tons or man-days or some similar unit. Considerable care must be exercised even with physical units to select the unit most likely to be economically significant. Is it better to bring all the different varieties of cotton cloth together in a single figure by measuring them in running yards, in square yards, in pounds, or in some other unit? Each segment presents a special problem. Often the choice is dictated by the available data though in other cases and in most cases so far as the collection of new data is concerned, some latitude of choice in physical unit is open.

In many cases variations in quality which cannot be easily reflected in physical terms are so great that a deflated value unit is preferable to a physical unit. Thus, in the case of shoes, variation in the average quality of shoes produced is so great from year to year that no simple physical unit appears satisfactory as a measure of shoe output. Certainly the mere number of shoes produced is not an economically significant measure of output when year-to-year production is to be compared. However, a quasi-physical figure of shoe output can be obtained by taking the total value of shoe output in each year and dividing this by an index of shoe prices. By this method, if the proportion of shoes of different qualities produced remains constant, but the number of pairs of shoes produced increases, the index of output will rise. Likewise, if the number of pairs of shoes produced remains constant but the proportion of high quality shoes increases, the index of output will rise.[1] Thus variation in both quality and quantity can be partly reflected as a variation in output.

Where both physical and value data on an input or output item are lacking, it may be necessary to develop an index of variation of the particular item by using data on some other item. In practically all the analyses of service industries, an input item (man-years) was used as a measure of consumption in working out the consumption relationships in place of the unavailable output item. Steel ingot production, an intermediate item within the steel segment, was used as proxy for the output of finished steel. Mill consumption of raw cotton was used as a measure of the output of finished cotton textiles, and a consumption relationship was developed with this item as dependent variable.

Such a procedure is entirely justifiable as a makeshift in the absence of more complete data. It merely involves the telescoping of two or more relationships that would normally appear "in tandem." Thus the more complete analysis of the cotton textile segment would include—

(a) A consumption relationship connecting finished cotton cloth output with consumer income, and other factors, and

(b) An input-output relationship showing the mill consumption of cotton required for given quantities of the output item.

Tracing back from consumer income to mill consumption would normally include two (or more) steps:

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[1] Provided, also, that any changes in the index of shoe prices reflect only changes in price for shoes of constant quality. To the extent that changes in the index of shoe prices reflect changes in quality, the quasi-physical index described above does not take full account of changes in quality.

$$\begin{tikzcd} \text{Consumer income} \arrow[r] & \text{Cotton textile output} \arrow[r] & \text{Mill consumption} \end{tikzcd}$$

The short-circuiting procedure eliminates the intermediate step and the inference moves immediately:

$$\begin{tikzcd} \text{Consumer income} \arrow[r] & \text{Mill consumption of cotton} \end{tikzcd}$$

Whether this telescoping can be done without significant loss of accuracy has to be examined in each individual case. In the above example, changes in the inventory of unfinished items intermediate between cotton and finished textiles, e. g., yarn, could throw out the relationship and probably explain in part the relatively poor results obtained in the cotton textile analysis which had to be based on mill consumption of cotton in the absence of other data.

B. Factors Likely to Appear in Consumption Relationships

The preceding section discussed the items of input and output pertaining to an individual segment. These items may be elements in either consumption or conversion relationships.

Consumption relationships link a segment with its economic environment; an item of the segment (preferably an output item) is expressed as a function of factors outside the segment. For instance, cotton cloth output is related to consumer income as represented by national income paid out; the output of coal, with manufacturing production; and the output of tire fabrics to activity in the tire-manufacturing segment.

Input-output or conversion relationships (to be considered in C below) are internal to the segment. They connect an item of input with an item or items of output, and perhaps other factors pertaining to the segment such as technological processes. For instance, the input of man-days in bituminous coal mining is related to the input of coal and to type of mining, open pit or underground, to size of mine, and degree of mechanization.

This section discusses the "outside" factors and other variables likely to be related to segment items, and suitable for inclusion in a consumption relationship. There are some general factors which appear to be significant for nearly all segments. These are (1) the general level of economic activity as measured by consumer income or by industrial production, and (2) change through time.

In addition, there are specific variables which relate more particularly to one segment or relationship. One of these, which appears in a number of the consumption relationships, is the real price (specific price divided by general price level) of the dependent variable in question, e. g., real railroad passenger rates. Occasional use is made of other specific variables. Thus a consumption relationship for bituminous coal makes use of an efficiency index which purports to measure the efficiency in the conversion of coal into useful energy. Automobile retail sales are found to be heavily influenced by the existence in use of old cars as measured by the number of cars 7 years of age or older. All these are variables relating wholly or chiefly to parts of the economy rather than the economy as a whole, and so are called specific variables as opposed to general.

It will be noted that the general price level (as measured by the Bureau of Labor Statistics cost of living index) may enter both as a general variable and a specific variable. It may occur as the deflator in consumer income, a general factor; and as a deflator for specific prices in calculating the real price of an article, a specific factor.

1. *The level of economic activity.*—Many different indexes exist which roughly indicate the level of economic activity such as indexes of national income paid out, of industrial activity, and of employment. For the purpose of segment analysis the most satisfactory procedure from the logical point of view would be to use two separate indexes, one reflecting variations in ultimate consumption and a second reflecting variations in new capital goods created. It is well recognized that the variations in these two activities are characteristically different, the two indexes together reflecting the level of economic activity. However, no adequate indexes covering these two factors exist. Until such are developed, indirect methods will have to be employed to take account of them.

To take the place of indexes of consumption and of new capital goods created, two indexes appear particularly useful, first an index of consumer income, represented by national income paid out adjusted for price changes, and second, the Federal Reserve Board index of industrial production. The index of consumer income is in large measure an index of consumption. The index of industrial production reflects both the manufacture of consumption goods and the manufacture of capital goods, but it gives about equal weighting to the two basic factors.[2] It is possible by using both an index of consumer income and an index of industrial production to introduce the combined influence of consumption and of capital goods creation, with varied weights for the two components, though they cannot yet be dealt with in an unmixed form.

It may be thought that consumer income and industrial production vary so closely together that either alone would be sufficient. Experience with segment analysis has shown that the difference in their variations is important. Thus in analyzing the consumption of bituminous coal both indexes were found to contribute significantly to the analysis. Likewise, in analyzing American imports both indexes appeared to contribute. Only the index of consumer income appears to be significant for some items, particularly such consumers' goods as gasoline, while for other items, chiefly producers' goods or services, such as freight traffic or steel consumption, the index of industrial production alone appears to be significant. In general, consumers' goods were found to be related more closely to consumer income, producers' goods to industrial production.

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[2] Manufacture was divided about equally between consumption goods and capital goods in 1929, when measured by the value added by manufacture.

2. *Measuring consumer income.*—Consumer income (in current dollars) is measured by the national income paid out. The theoretical questions which arise in defining the national income are introduced in *National Income, 1929–35*, published by the Department of Commerce; also in the publications of the National Bureau of Economic Research. The chief points of difficulty in definition and measurement are, what to do with the business savings of entrepreneurs, and what to do with the services derived from owned durable goods, such as houses. In most of the recent studies of national income, including that of the Department of Commerce the last point has been avoided by restricting national income to actual cash receipts; imputed income, so-called, being excluded. Capital gains and losses are also excluded.

The "income paid out series" of the Department of Commerce was therefore adopted for the purposes of this study, with one amendment. This was the treatment of entrepreneurs' savings. In the series of the Department of Commerce, the income of entrepreneurs (their net income as businessmen) is divided into two parts, (a) labor allowance, generally equal to the earnings of full paid salaried employees in the same business, and (b) business savings. This method of treatment incorporates entrepreneurs, as it were, and makes them salaried employees of themselves in their corporate capacities. Only the labor allowance is included in income paid out. Their business savings are excluded, but for the purposes of this report the separation does not appear advisable. The business savings of entrepreneurs are at their disposal for expenditure on consumption goods, in a way, and to an extent to which corporate savings are not available. The owners of a corporation do not have access to or control over the spending of the corporate savings, and the latter are therefore properly excluded from "income paid out." Entrepreneurs do have access to their business savings and these should be included, at least in part, in income available for expenditures on consumption.

In this study, therefore, consumer income (in current dollars) is represented by the amount of money actually coming into the control of individuals for spending, in return for goods and services rendered. It is represented by the national income paid out, as published by the Department of Commerce, plus the savings of entrepreneurs.

This national income series was extended back to 1919 by splicing the Department of Commerce data to the corresponding series published by the National Bureau of Economic Research in national income and capital formation 1919–35.

Consumer income was calculated by deflating the above income series by the Bureau of Labor Statistics cost of living index. It is shown in table I of Appendix 2.

3. *Accounting for change through time.*—In addition to variation in basic economic activity the trend of change through time appears as a general variable. Unlike consumer income, time trend is an indiscriminate catch-all which acts as a proxy for the trends in other factors not separately treated. Of the numerous factors influencing coal consumption, many change through time in such a fashion as to contribute to a regular change in coal consumption with time. Thus, the introduction of improved house insulation gradually reduced the aggregate coal requirements for heating a given number of houses. The increase in the population and in the number of houses calls for a fairly continuous increase in coal. The gradual replacement of old with improved furnace equipment reduces the consumption steadily over a period. A whole series of factors, some operating in one direction and some in the opposite, produce a net change through time, the trend of which can be accounted for in the formula representing the relationship between different factors.

The use of time as a factor in the analysis introduces problems not implicit in the other factors discussed. Since time trend reflects the net trend of a variety of factors it is in itself a less dependable factor. Will the various influences which combine to give a time trend continue to operate to produce a continuation of trend? A very considerable element of error in estimating future relationship can arise through the inadequacy of the extrapolation of time trend since a small initial error can be magnified into an important error as the extrapolation is extended over a period of years. For this reason, the use of time as a factor involves serious risks and limitation.

To reduce the risks of error arising from the use of time trends, the factors underlying the time factor factor should, as far as possible, be accounted for directly and not through the proxy of the time factor. Thus, in the case of bituminous coal consumption, it would be possible to parallel most of the variation in coal consumption by using as factors consumer income, industrial production, the ratio of coal to fuel oil prices, and a time factor. On this basis, the time trend obtained shows a rapid decline of coal consumption through time. When, however, an index of efficiency in the use of coal is introduced as a factor, most of the decline in coal consumption through time becomes attributed to the increase in the efficiency in coal utilization and only a small amount remains to be accounted for by time factor. That is, the time factor becomes of minor significance and large error in the extrapolation of this proxy variable will introduce only a minor error in the final estimates, while the underlying efficiency in coal utilization can be watched and followed currently. There is the further advantage that all of the variations in this factor contribute to the equation instead of only that part which follows a smooth time trend.

The importance of replacing the time factor by the factors underlying it can be clearly seen in the actual experience with coal consumption. The efficiency in the utilization of coal increased fairly steadily from 1919 to 1930 so that a time trend showing a steadily declining consumption of coal was not inadequate to reflect the influence of this increasing efficiency. During the depression there was apparently little increase of efficiency in the utilization of coal, that is, the trend so failed to continue the predepression slope that the extrapolation of the time function through the depression was significantly in error. This error would, of course, be eliminated by accounting for the influence of changing efficiency directly through the introduction of an index of efficiency into the analysis and continuous checking of efficiency by engineering studies.

4. *Specific factors: Relative price.*—In developing a consumption relationship it is always necessary to take either direct or indirect account of variation in relative prices or else to make sure that relative price variations are not significant for the purpose in hand. For many items, particularly agricultural commodities, it is possible to take direct account of relative prices, introducing price or the ratio of price to a general index of prices, into the analysis. For some items, variations in relative price may prove to be of negligible significance. Such appears to be the case with gasoline, the use of automobiles being little affected by such variations in gasoline price as have occurred in recent years. Variation in relative price may be significant for a host of other items, yet because of the characteristics of these price variations, it may not be possible to take direct account of them.

It should be noted that the objective of this study is not to determine the "effect" of price and other factors on demand, but simply to be able to calculate the demand from a combination of these factors. It does not follow that unless we know the price of an article, we cannot say how much of it will be consumed, within limits. To take an extreme case, the per capita consumption of staple foods as a group goes along pretty steadily from year to year, so that one can calculate it fairly accurately without a knowledge of price. The same is true of all commodities having a small price elasticity.

Even where the elasticity is moderate or large, it is not always necessary to take explicit account of price. The influence of price may be transmitted through other variables appearing in the equation. If the cyclical element in price is correlated with, say, the Federal Reserve Board index of production, that factor can to an extent take over the job of measuring the contribution of price. The trend element in price can be accounted for in the general time trend. In the case of electric power, rates show a fairly steady decline over a period of years, which a time factor can closely reflect. There is a small, though perceptible, cyclical element, the decline being more rapid in the down-swing of a depression and less rapid in the up-swing of recovery. As a result, most of the variation in price would be accounted for by a time factor and an index of economic activity. It is, therefore, not necessary to obtain an independent measure of the influence of price variation in order to estimate the demand for electric power.

5. *Other factors.*—In addition to the general factors and the relative price, it may be necessary to introduce other factors into the analysis. The efficiency index used in the case of coal consumption and the number of automobiles in operation used in the gasoline consumption analysis are examples. Since these factors will vary from segment to segment, no general discussion of them can be given. Their introduction will depend on the characteristics of the particular segment.

Once the factors regarded as likely to be related to consumption have been decided upon for a particular segment a working hypothesis should be set down indicating the relationship which is believed to exist between these factors. This then becomes the hypothesis to be tested by actual data.

C. Factors Likely to Appear in Input-Output Relationships

In consumption relationships, general factors relating to the economy as a whole assume a prominent place, but in conversion or input-output relationships the only general factor to appear is change through time.

Time appears as a proxy variable, representing changes in technological efficiency and other factors. There is a good deal of regularity in the rate of improvement of technology from year to year, and a smooth trend is fairly well adapted to representing this progress. The persistence of trends in technological improvement are usually such that the projection of trends in input-output relationships into the future is attended with only minor risk. It is, however, highly desirable to replace the time factor by some direct measure of technical improvement such, for instance, as an index of mechanization derived from data relating to the type and quantity of machinery in place. Unfortunately, little of this type of data is available over a long period of years.

One specific factor appearing in every conversion relationship is output, except where the lack of data may require the substitution of some other item. An example of such a substitution is to be found in the steel segment in which man-hours have been expressed as a function of steel ingot production, instead of output of finished steel.

In the analyses of conversion relationships contained in this report, the only item of input which has consistently been given attention is that of manpower either in the form of man-hours, man-days, or equivalent full-time employment.

Again the working hypothesis relating the several factors should be set down as a basis for testing by actual data.

IV. Data and Data Adjustments

Once the variables likely to appear in the relationship have been selected and a working hypothesis as to their relationship has been established, data must be assembled from various sources, organized and frequently adjusted to lay the basis for testing the hypothesis.

Adjustment includes interpolating data for years in which it is not available in the form desired, calculating man-hours, allowing for changes in inventories, adjusting for exports and imports, and calculating price indexes.

A. Sources

Primary sources do not often present data in the form required. They are most frequently inadequate in respect to coverage. Many research organizations have attacked the problem of building up full-coverage estimates from basic data, notably in the field of employment statistics. Such estimates were used wherever possible. As a general rule, employment figures of the Department of Commerce, estimated in connection with the latter's studies of national income,[3] were used, and accepted as standard, particularly for the segments covering the services to the economy, services to the consumer, trade, construction, and some minerals. The most recent revisions were made available by the Department. These employment series were carried back from 1929 to 1919 by splicing on estimates supplied by the National Bureau of Economic Research.[4] The production and man-hour estimates built up by the National Research Project of the Works Progress Administration were used for a few of the manufacturing segments.

In other manufacturing segments man-hours were based on the Census of Manufactures and the Bureau of Labor Statistics employment indexes. The method is described below. Since this census is published only every other year, figures for the intervening years were interpolated by the process also described below.

Other data, e. g., on output, were drawn from the Census of Manufactures, Bureau of the Census, Bureau of Mines, etc., and from secondary sources such as the Survey of Current Business, and Commerce Yearbook.

Sources are stated in the summary analyses of individual segments which appear in the Appendix 2.

B. Calculating Man-Hours in Manufacturing

Labor input is measured in terms of man-hours in most of the manufacturing industries. Man-hours are determined by multiplying the number of employed by average hours worked per year (52 times the hours worked per week) or by dividing the total pay roll by the average hourly earnings. Employment and pay rolls are both reasonably accurate, based as they are on the Census of Manufactures, but the other factors are measured only by samples. The Bureau of Labor Statistics' monthly figures on earnings and working period are available from October 1932. The National Industrial Conference Board data are available, as far back as 1920, but only for 25 manufacturing industries. The occasional wage and hour studies of the Bureau of Labor Statistics give data pertaining to short periods of 1 to 3 months, approximately every other year.

In these studies the chief difficulty was found in the period prior to October 1, 1932, especially in those industries not covered by the National Industrial Conference Board. In some cases average hours worked per week prior to October 1932 were assumed to vary in proportion to hours in some related industry covered by the National Industrial Conference Board, or in proportion to hours in manufacturing as a whole. In others the "prevailing hours of work" as reported in the Census of Manufactures, adjusted by a correction factor, were used to get a general indication of how working time changed, though this is merely suggestive, for the purpose in hand. The occasional wage and hour studies of the Bureau of Labor Statistics, when available, furnished scattered bench marks into which the trends indicated by the above less reliable figures could be tied.

C. Interpolating Data for Nonreporting Years

Since the Census of Manufactures appears for only odd-numbered years, value, production, and wage-earners data, etc., must be obtained for the evennumbered years by interpolation. A method commonly employed was as follows: A series x (hereafter called the comparison series) is selected which is known to correlate closely with the series to be interpolated, y (hereafter called the interpoland). Thus the value of cotton consumption, estimated annually by multiplying the quantity consumed by the average price, ought to correlate fairly well with the value of finished cotton goods, available only in census years, and might be used for interpolating the latter. The number of rubber tires produced, as reported monthly by the Rubber Manufactures Association, but covering only about 80 percent of the industry, should have a high correlation with total production as reported every other year by the census, and should prove a very satisfactory comparison series.

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[3] See, for example, *The National Income, 1929–35*, loc. cit.

[4] Not yet published by the Bureau.

The following method, which was used in some cases, is believed to have certain advantages over the straight-line interpolation methods. It does not assume proportional variation, but merely that the interpoland and the comparison series are related in some way, for example,

$$y=Ax+B+\text{residuals}$$

or

$$y=(\text{time trend})\ x+B+\text{residuals}$$

The coefficient of x may be a constant, A, or may vary with time as in the equation just above. The relationship is determined, generally by graphical methods, and the residuals found. These residuals are then interpolated, graphical methods being quite satisfactory, and are added on to the calculated value from the formula to give the interpolated figure in intervening years.

The method is illustrated in an analysis of the shoe segment which appeared in Econometrica of October of 1936.[5]

D. Adjustment for Inventory Changes

Consumption, i. e., purchases by ultimate consumers, is the variable which should appear in a consumption relationship, but most industrial statistics refer to output rather than consumption. Only a few actual consumption series are available. When inventories do not vary much, or do not exist at all, as in the case of electric power, it is legitimate to use production as a measure of, or as an index of, consumption. When inventories do vary, it is advisable to make some adjustment for stocks, even if only a rough indication can be obtained as to how they have changed.

A procedure used in the shoe segment for getting an adjustment for stocks was as follows: It was noted from the Census of Distribution, 1929, that at the end of that year retail shoe stores had an inventory with a value equal to about one-third of the year's sales. Assuming that this is representative, the average interval between manufacture and sale to ultimate consumer may be taken at about 4 months. This is a low estimate rather than a high one, because no account is taken of manufacturers' and wholesalers' stocks, or of goods in transit. The calendar year value of output figures were charted, and interpolated with a smooth curve. The wholesale value of shoes consumed was then taken as the value of this smooth curve between calendar-year figures, two-thirds of a year from the earlier year, and a third of a year before the later. Roughly, but not quite exactly, this procedure implies that the wholesale value of consumption in 1929, for instance, equalled the value of production in the 12 months ended in August. The process smooths the figures somewhat, in addition to lagging them by about 4 months, which is also desirable, because purchases by consumers in all probability display less variation from year to year than production.

E. Adjustment for Exports and Imports

Adjustment for exports and imports presents no serious difficulty. Exports are subtracted from, and imports added to, the output or input of the commodity. If value figures are used they may be converted to a quasi-physical basis by deflating by price. Thus the output of shoes for the domestic market is measured by value of factory output, less value of exports, plus value of imports, and the net result is divided by an index of shoe prices.

F. Price Index Construction

There is a dearth of adequate price data relating to a considerable number of segments. In some cases price can be ignored anyway, for reasons given earlier. In others, it is possible to introduce the price of a similar commodity with not unsatisfactory results. In still other cases special price indexes can be constructed. This was done for a number of segments. For example, in the case of the post-office segment, an index of postal charges was constructed from the rates for mail of various classes, as furnished by the Post Office Department in Postal Rates, Abstract of Laws Passed.

V. Selecting the Form of Relationship

With the basic data in hand, the next step in testing the hypothesis as to the relationships between factors consists of giving precision to the hypothesis concerning the factors selected and the nature of the form of the relationship. That is done by fitting a general function to the data by graphical and numerical methods. The basic problems and techniques involved in doing this are adequately treated in standard texts.[6] These need not be described here, and discussion will be confined to modifications of these general methods which have been used.

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[5] von Szeliski, Victor, and Paradiso, L. J., *The Demand for Boots and Shoes as Affected by Price Level and National Income*, Econometrica, October 1936, p. 349.

The first step in developing a statement of the relationship underlying a particular segment was to utilize a graphical method of analysis. The graphical method developed by L. H. Bean,[7] when used with care, will show, with a minimum expenditure of time, whether the hypothesis to be tested is consistent with experience. This method will also give the technician employing it a proper "feel" of the material he is handling, a very clear impression of the interaction of changes in different factors and of the tolerances within which an alteration in the values assigned will involve an appreciably different fit. By getting this "feel" of the material, serious errors in the evaluation of the results of the analysis can often be avoided and fruitful new lines of investigation may often be suggested. In each segment analysis this graphical method was therefore employed up to the point where it was possible to determine whether or not relationships between the series existed, and to get a clear indication of their nature,[8] such as whether the variables bore a multiplicative or additive relationship to each other and whether the relationships tended to be linear or curvilinear and if the latter of what character.

Once the existence and general character of the relationship was established, by graphic correlation, numerical methods were used to derive simple mathematical formulas expressing the relationships indicated insofar as they were capable of being stated in simple formulas which meet the "least square" criterion. With few exceptions the relationships indicated by the graphical analyses could be represented by one or another of a few simple types of formulas,[9] and the numerical work was thus readily routinized so that final statements were obtained with little additional effort. Though in this procedure mathematical formulae were developed to give a mathematical statement of the relationships developed by graphic analysis, the final results were dominantly conditioned by the graphic analysis, and the empirical relationship disclosed in that analysis.

In both the graphic and the mathematical steps of this procedure empirical and logical considerations were involved as well as certain considerations of expediency. The question of multiplicative versus additive or more complex forms of relationship had to be considered both from the point of view of logic and in the light of the relationships shown by the actual data. When the graphic analysis clearly indicated a particular relationship such as an additive one, this was adopted regardless of what was thought to be the more logical relationship, but where the graphic analysis disclosed alternative types of relation to be equally suited to the data the more logical relationship was adopted. This same procedure was adhered to throughout the analysis except where expediency either in the graphic or the mathematical step called for a departure. Thus where an additive graphic analysis indicated that the relationship was clearly multiplicative and this was supported by logical conditions the graphic analysis was not carried out in a multiplicative form. In the same situation simple curves were used in mathematical formulation except where the graphic analysis indicates that significant discrepancy would result in the upward extrapolation from the relationships. Where significant discrepancies appeared likely to arise a more complex formula was employed.

The various types of simple mathematical formula which would be employed in giving a generalized statement of the relationships disclosed by graphic analysis are discussed below along with the logic which would lead to the use of one or another where it was supported by the graphic analysis or where no clear indication of the nature of the appropriate formula was given by the graphic analysis of the data itself. As already indicated, where the graphic analysis clearly indicated the use of a formula different from that suggested by logical considerations, the results of the graphic analysis were followed. The two most simple forms of equation, the additive and multiplicative, are given below, as applied to the relation between manpower, output, and a time trend.

$$\text{Man-hours} = \text{time trend} + \begin{array}{c}\text{net relationship}\\ \text{with output}\end{array} \qquad (1)$$

$$\text{Man-hours} = \text{time trend} \times \begin{array}{c}\text{net relationship}\\ \text{with output}\end{array} \qquad (2)$$

According to the first of these formulae, if man-hours declines with time, as it does in most industries with improving technology, the decline would be independent of the level of output, whereas in the second formula it would vary with output. The latter would appear to be the more logical relationship for most industries though graphic analysis might disclose specific exceptional cases.

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[6] See Ezekiel, Mordecai, *Methods of Correlation Analysis*, John Wiley & Sons, New York, 1930.

[7] Bean, L. H., A Simplified Method of Graphical Curvilinear Correlation, *Journal of the American Statistical Association*, volume XXIV, pp. 386-397, December 1929.

[8] It would be possible to use either the graphic or the mathematical method of correlation analysis as the sole method of determining the shape of the regression function. Some believe the mathematical method should be used only when there is some dominant logical basis for the equation chosen (see, for example, Ezekiel, *Methods of Correlation Analysis*, pp. 88-91, 97-108), whereas others believe the graphic method does not give a basis for evaluating the assumptions implicit in the curves developed on a free-hand basis. The authors of this report believe there are advantages to be derived from the two methods in combination over either one separately. Since the matter is controversial no stand is being taken in this report on the relative advantages and disadvantages of the two methods when used separately or in combination.

[9] Arithmetical combinations of linear and power or exponential forms.

The same choice between additive and multiplicative combination of factors presents itself in consumption relationships. Consumer income, (CI), real price (RP), and a time factor are the factors commonly used. The more important ways they could be combined are given below:

$$\text{Consumption} = (\text{time trend}) + (\text{net relationship with CI}) + (\text{net relationship with RP}) \quad (3)$$

$$\text{Consumption} = (\text{time trend}) \left[\begin{array}{c} (\text{net relationship} \\ \text{with CI}) + (\text{net} \\ \text{relationship with} \\ \text{RP}) \end{array} \right] \quad (4)$$

$$\text{Consumption} = (\text{time trend}) \times (\text{net relationship with CI}) \times (\text{net relationship with RP}) \quad (5)$$

Similar reasons for having the time trend multiply into the remaining factors apply here as in the man-hour example. It would seem that the effect of the time trend ought to depend on the level of consumer income and of the price. And the same with the price effect, it ought to depend on the level of consumer income and the time factor. But equation (3) assumes that the rise or fall in consumption due to a change in price is the same, no matter at what level consumer income or the year may be. So (3) may be rejected. Equation (4) is open to a similar objection. Equation (5) appears to be the more logical one to use.

Next, the explicit form of the mathematical functions used to represent the time trend net relationship may be considered. The time trend, for example, could be described by such functions as a straight line, a power curve of low degree, an exponential curve, or a logistic. If the time trend curve is almost flat, all the curves would agree closely in their extrapolated values for two or three years, and any one of them could be chosen. However, if the trend falls rapidly, the straight line may have to be ruled out because it reaches impossibly low values very quickly and eventually becomes negative. Second- or third-degree curves are notoriously liable to large errors in extrapolation. For these reasons the exponential curve $(1+r)^t$, where t is the time variable and r is a constant, is the more logical form in most of the relationships. It possesses the requirements of remaining positive throughout, of flattening out asymptotically to either right or left, and of being a fairly inflexible curve of slowly changing curvature. In those cases where the graphical analysis disclosed a departure from the compound interest curve, other curves were used such as the more flexible exponential curve $a+b(1+r)^t$.

The explicit form of the functions representing man-hours-output net relationships are subject to similar considerations. Two of the curves most commonly considered for these studies were the straight line and the fractional power curve, expressed in the forms given below:

$$MH = (1+r)^t \times (a+bP) \quad (6)$$

$$MH = (1+r)^t \times BP^\alpha, \quad (7)$$

$$MH = (1+r)^t \times (A+BP^\alpha). \quad (8)$$

Here MH is the number of man-hours, $(1+r)^t$ is the exponential time trend mentioned above, P is output, $a+bP$ is a straight line, and BP^α is a power curve.

Since the economic operating characteristics of industries are not the same for all industries, none of these formulas would be suitable for all cases. The presence in many industries of a significant amount of overhead or indirect labor for maintenance results in total labor requirements which rise and fall less in percentage than the output. Since equations (6) and (8) involve a constant term, either is well adapted to represent that labor which is independent of output. However, equation (7) may fit the data equally well and may be a close approximation to the condition represented by the other two equations.

In those industries where a rapid increase in output results in the operation of the less efficient plants the added input per additional unit may increase. This means that if equation (7) or (8) is used the value of α should be >1. In other industries an increase in output may result in a decrease in the input per additional unit since high production levels may stimulate the use of improved technology. In such cases $\alpha<1$ would be satisfactory and equation (7)[10] or (8) can be used.

Thus it is clear that a knowledge of the operations of an industry is necessary in setting forth the logical conditions regarding the form of the relationship.

Attention may now be turned to the income and price terms in the equation,

$$\text{Consumption} = (1+r)^t \times (\text{net relationship with CI}) \times (\text{net relationship with RP})$$

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[10] Although equation (7) was employed in the majority of the manpower analyses, it is not intended to give the impression that this form is necessarily the logical one to use in all such cases. One of the properties of this equation is the fact that when production is zero, man-hours is also zero. Such a condition may or may not be consistent with reality, depending on whether indirect labor would or would not be employed if the output of the industry were to drop to zero. Furthermore, since the lowest production levels utilized in the analyses are considerably above the zero level of production, the shape of the function is indeterminate for those values of production lying above zero and the lowest observed value. Consequently, the assumption that the function given by (7) describes the relationship within this range may have no validity. Possibly, a more logical equation might be one which is of the multiplicative form and whose factors involve additive terms. Such an equation would not contain any a priori assumptions as to what the value of man-hours would be if production were equal to zero. Equation (7) was, nevertheless, employed because of the facility with which it could be fitted to the data and because, where it was employed, the graphical analysis indicated that the fit over the range of observations was just as good as that which would have been obtained if other types of multiplicative forms had been used. The fact that in so many analyses this type of equation continued to give a good fit for the years following 1932 (which were not used in determining the constants of the equation) also tends to substantiate this result. Furthermore, since the equations were used to extrapolate with values above the observed values, rather than with those toward the origin, no particular difficulty is presented in the use of equation (7).

It has already been indicated why the net relationships of these two factors should be multiplied together instead of added; the probability that the effect on consumption of variations in one factor depends on the values of the other factors. The explicit forms of the functions representing the effect of consumer income and real price are the same simple forms as are discussed in the man-hours output relationship and the logical basis for considering these forms is analogous to that already mentioned.

With few exceptions the parameters in the equations finally used were derived by the least squares method, which is fully described in standard texts on correlation analysis. In those cases where modifications of linear, power or exponential forms were employed, the first approximations to the constants were obtained by the method of selected points.[11] When necessary these constants were more precisely determined by successive applications of the method of least squares.

For example, in the manpower analysis for iron and steel the form of the equation finally used was,

$$MH=(a+bt)\,P^{\alpha}. \tag{9}$$

The constants in this equation were determined by first applying the least squares method to the exponential form (7). The specific equation thus obtained was then used to calculate the expression $\frac{\text{actual } MH}{P^{\alpha}}$. Using this expression as the dependent variable, the method of least squares was then applied to the equation

$$\frac{MH}{P^{\alpha}}=a+bt,$$

to determine the constants a and b. The result led to equation (9).

VI. Tests of Fit and Reliability

The formula derived in the above analysis must then run the gauntlet of criticism and testing on the basis of experience.

1. *The fit of the formula.*—The test of experience will include such questions as these: How closely do the calculated values agree with the actual? For how much of the variation in the estimate does the formula account, and what is the standard error, according to the standard formulas of mathematical statistics? Above all, how closely does the formula fit the data for the subsequent years, 1933, 1934, 1935, and 1936? (It will be remembered that with a few specific exceptions, data through 1932 only were used in fitting the equations, data for the subsequent years being reserved for this very purpose of testing reliability.) Where does the actual diverge widely from the calculated value, and can such divergence be accounted for by special or unusual circumstances existing at the time? How important is the time trend?

The statistical questions are answered by standard multiple correlation techniques, and need not be explained here.

2. *Analysis of residuals.*—However, study of the residuals—of the large deviations between actual and calculated—should not be passed over. The large residuals indicate the important influence of factors not taken account of by the statistics; often factors which can be identified, but cannot easily be measured. Examples are strikes, floods (such as the floods in March 1936, which caused interruptions in production of certain industries), the Ford model change from model T to model A in 1927, introduction of new methods, and so on. If the existence of such nonrecurring factors in certain years can be established, it is probably best to omit the affected years from the data and redetermine the relationships. Thus, in the case of the consumption relationship for automobiles, the data used were for 1921–26 and 1928–32. Retail sales for 1927 were down because of the sheer nonavailability of Ford cars, not because of any defect in consumer purchasing power. The man-hours relationship for anthracite mining was established from data for 1924–32 because previous years were too much upset by strikes.

The effort to account for residuals will often bear fruit in an improved understanding of the operating characteristics of the industry. Running down the causes of large residuals may direct attention to variables hitherto overlooked, and suggest ways of improving the formula.

Studying the large residuals also gives an idea of how likely the formula is to hold up under unusual circumstances—of how much it can be thrown off by new factors entering the situation. It shows the analyst what sort of things to be on the lookout for in following the current developments in the industry.

3. *Agreement with theoretical considerations and known facts.*—Besides the statistical tests, there are theoretical considerations. For example, if the exponent of price in a consumption relationship comes out positive, the formula would appear to be illogical, for it would indicate that increased consumption went along with increased price. To be sure, no claim is made that the net relationships are separately and individually correct and that they indicate the true effects of the particular factors on the estimate, but there must always be an element of uneasiness in using a relationship, a component factor of which has characteristics at variance with a priori expectations.

Another example would be a man-hour relationship with an upward sloping time trend for an industry where it was known from engineering sources that man-hour requirements had gone down due to extensive mechanization. Results like these should be questioned irrespective of goodness of fit. They indicate strongly that the analysis disregarded an important factor or factors, the influence of which was being transmitted through some other factor as a proxy variable.[12]

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[11] See F. C. Mills, *Statistical Methods*, Henry Holt & Co. (1924), p. 299.

VII. Improving the Formulas

1. *Revising and improving the formula.*—Once a reasonably reliable formula has been developed, there still remains the process of revising and improving it. This process needs no discussion since it is essentially a repetition of the processes of developing, testing, and criticizing the formula except that it has the results of that work to start from. Where the formula is found to be reliable in extrapolations, the 1933–36 data can safely be used for refitting the formula, thus furnishing a slightly more accurate formula for projection into 1937 and 1938. Where the formula does not extrapolate reliably, it may be necessary to use the data from 1933–36 for refitting the formula but the revised formula cannot be regarded as at all reliable until data for subsequent years have shown that it extrapolates reliably. As fresh data become available or as new factors seem worth taking into account, the formula can be reworked. Gradually, over a period of years the different formulas can be tested by further experience and adjusted to new conditions. This process of constant readjustment and improvement is implicit both in the development and in any continual use of such formulas.

Usually the improvement in a relationship will consist of introducing new variables to replace proxy variables, and especially the time trend. Thus the early studies of the consumption of coal used a time trend, yet later an independent index of efficiency of coal utilization was introduced which materially decreased the variation which was accounted for by the catch-all "time."

Study of a segment may also suggest the desirability of splitting it into subsegments in order to obtain greater homogeneity in each. The improvement may take the form of having two or three relationships in place of one.

VIII. Constructing Conversion Patterns

Once the basic relations underlying each major segment in the economy have been worked out more or less precisely and stated in a formula, the next problem is to construct conversion patterns. This involves two different steps; first deciding on the particular system of assumptions to be introduced into the respective formulas—what size of consumer income, what prices, etc.; second, substituting the assumed numerical values in the formulas so as to obtain a statement of the conversion activity likely to take place in the light of the system of assumptions adopted and the relationships previously derived from experience.

1. *Developing the basic assumptions.*—In addition to the formulas developed above, there are both general and specific assumptions basic to any particular conversion pattern. The first of these includes assumptions as to such variables as the size of consumer income, the level of industrial activity, and the characteristics of income distribution. The second set of assumptions is of a more specific character related to specific industries, as for instance the ratio of fuel oil to coal prices or of railroad passenger rates to cost of living. Both of these types of assumptions need to be considered in detail.

The two most important general variables about which assumptions need to be made in constructing a conversion pattern are consumer income and industrial activity, two variables which tend to be related. The range of possible combinations of values for these two variables is limited by the fact that they are not independent. While consumer income and industrial production do not fluctuate in identical fashion, they tend to be fairly closely related. Therefore, the values introduced for these two factors should be consistent. The difference in the figures introduced for these two factors should not be significantly greater than the divergences that have existed in the past.

What other general assumptions need to be introduced can only be determined in the process of analyzing the separate segments. The influence of such factors as population may be taken account of in time trends or these factors may have to be introduced directly and values assigned either on a basis of forecast, as the population a year hence could be estimated, or by the trial of various possibilities, as is proposed with consumer income. The exact procedure should be worked out for each general factor in the light of the experience gained in the analysis of segments.

In constructing the patterns which appear in the report it appeared desirable to have a basis for selecting the index of production to be paired with consumer income. A relation was worked out between the two, as follows:

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[12] In a few cases, the analysis yielded values for the coefficients which seemed to be absurd in spite of the fact that the factors used appeared to be logical and the variance which they explained was very high. When these analyses were further investigated it was found that the absurd values resulted from the high intercorrelation which existed between two or more of the independent variables. While the net relationships involving these highly associated variable were unreliable, the various tests showed that the relationship as a whole appeared to be quite reliable. Since the interest in these analyses, for the purposes of this study, lies in calculating reliable values of the dependent variable and not in the determination of net effects of the separate independent variables, the compensating character of the errors in the separate net regressions which result from the introduction of highly intercorrelated factors tends to minimize the errors in the gross estimates. Because some of the analyses contained in this study do contain factors which are highly intercorrelated, great care must be used in the interpretation of the net relationships of the separate factors contained in the formulas.

$$\underset{(1923\text{–}25=100)}{\text{Calculated industrial production}} = 0.2004\,(0.9837)^{\text{year}-1927}$$

$$\times \underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})^{1.5284}}$$

using the data from 1919–36; on the basis of which the following values were taken as corresponding:

Consumer Income (Billions of 1936 dollars)	*Corresponding index, industrial production* (1923–25=100)
50	68
60	90
70	113
80	139
90	166
100	195

Factors represented by time trends were assumed to have values as of 1938.

Specific variables such as real prices of individual commodities were assumed to be as in 1936, except where otherwise stated.

2. *Introducing the assumed values into the formula.*—The next step is calculation of the inputs and outputs for the various segments from the formulas developed. This is a mere matter of arithmetic and needs no explanation here. The resulting input and output items derived from each system of assumptions constitute the conversion pattern for that particular system of assumptions, that particular consumer income, etc. It is a statement in more or less detail of the industrial activity which seems most likely to take place under the assumed basic conditions.

APPENDIX 2
SEGMENT ANALYSIS

Introduction

For the purpose of constructing useful patterns of resource use, it was found convenient to divide the national economy into 81 industrial segments. This involved the making of 138 analyses, 81 of which were manpower and 57 of which were consumption. For each industry considered, an annual manpower series was related to the output for that industry and a time factor; in a few cases, manpower was related directly to such general factors as consumer income and industrial production. The consumption of the products of an industry was related to one or more of the general factors and, in some cases, to certain particular factors such as the average price of the products. With few exceptions, each analysis was made using only the data for the years of the period ending in 1932, reserving the available data after 1932 for testing the reliability of the relationships obtained. A graphical method was first used to determine the nature and character of the relationships indicated by the data. The final relationships were then obtained by applying the method of least squares to a mathematical equation.

The results of the analyses are shown in charts XXI–LVI in the body of the report, where the values as given by each formula are compared with the actual values. The patterns of resource used shown in table II of the body of the report are based on the extrapolations given by the formulas for various assumed levels of consumer income.

In this section, summaries of the methods as well as the factual data used are presented for 138 analyses. Each summary gives a brief description of the factors which were related to manpower or consumption and a table of the data representing the factors is also presented. A mathematical equation is given summarizing the results of the analysis for the years of the period ending in 1932.

A statement is given in each summary of the average percentage residuals for the years ending in 1932 to indicate the closeness of fit of the values as computed by the formula to the actual values. The percentage residual is derived from the ratios of the actual less the calculated values to the calculated values for the corresponding years. An empirical test of the reliability of the formula for the years beyond 1932 was made by the use of the percentage residual. For the purpose of this report it was decided arbitrarily that a formula was considered reliable if the percentage residuals for the extrapolated years beyond 1932 were not greater than 5 percent. For those cases not satisfying this condition, the formulas were considered to be less reliable and in constructing the patterns of resource use for such cases a formula was employed which was derived from all of the data through the recent years.

A more satisfactory method, particularly when each analysis is considered by itself, of indicating the closeness of fit and test of reliability is that employing the standard error of estimate. A residual (actual less calculated value) which exceeds twice the standard error of estimate is considered as significant (see R. A. Fischer, *Statistical Methods for Research Workers*, p. 44). According to this criterion, the formula may be considered reliable if each of the residuals for the years beyond 1932 is less than twice the standard error of estimate.[1] This method of presenting the significance of the results as well as the 5 percent criterion are shown in charts XI–XIII of the text.

One other method utilized to show the closeness of fit is also given, i. e., the percent of the total variance accounted for by the factors used. Economic series of the type which have been employed tend to have some degree of spurious intercorrelations and it is therefore necessary to set a high standard to the limit of significance indicated by the variance accounted for by the series. In most cases it was decided that if not more than 90 percent of the variance [2] was accounted for, then the formula was not to be considered very reliable.

Other measures and tests of significance can be utilized. For instance, one can calculate the standard errors of the constants in the equations which were determined from the data. Such measures, however, add little to the understanding of the analyses, particularly for the purpose for which they are used in this report. The interest of the analysis, so far as this report is concerned, lies in the combination of the factors used in the formula and not in the net effect of each individual factor. In some cases a high intercorrelation may exist between two or more factors, and, under these circumstances, it is practically impossible to obtain a sharply defined net effect of each factor separately. In such cases, the constants which are determined and the net effects of the individual factors may not be reliable. However, the combined effects of the several factors may very well yield a reliable result.

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[1] The usual tests of significance are applicable to random samples in which the observations are independent. Since these conditions are in general not met by economic time series, the application of tests of significance to such series is somewhat doubtful. The use of the standard error does, however, aid in the appraisal of the reliabilty of the results.

[2] The variance accounted for as given in the summaries is adjusted for the number of degrees of freedom remaining after accounting for the number of constants involved in the equation used. It should be pointed out that it is not possible to obtain a correct measure of the number of degrees of freedom left in correlation analyses involving economic time series since such series may be serially intercorrelated; for this and other reasons the observations may not be independent. The amount of variance explained, given in the analysis, is therefore only a crude indication.

It might be of considerable interest for other purposes to study the net effects or partial relationships given by the analysis. The partial relationships can be derived directly from the formula presented in each summary and they can be shown graphically by plotting the functional value of the factor as it appears in the formula against the value of the factor itself. The partial relationships must be used with great caution, particularly if cause and effect interpretations are to be imputed to them.

The dangers in making such interpretations are illustrated by the example shown in chart A which presents the partial relationships of passenger traffic with respect to consumer income, passenger rates, and time. The partial relationships are derived directly from the formula given in summary No. 9b. What interpretation can be derived from the relationships shown in panels 2, 3, and 4? Panel 2 shows the curve representing the partial relationship of passenger traffic with consumer income. It is obtained by plotting the term 0.6775 (consumer income) $^{1.0748}$ of the formula against consumer income. The points above and below the curve represent the position of the actual values in relation to the values given by the partial relationship. They are obtained by plotting the ratio of the actual value to the calculated value multiplied by the reading of the point on the curve for the corresponding year. The position of the points with respect to the curve indicates how well the relationship fits the actual data.

The relationship appears to show that if consumer income increases by 10 percent, passenger traffic could be expected to increase by 10.7 percent, provided all the other factors remain equal. The reliability of this statement depends on the reliability of the exponent, 1.0748, and in addition on the assumption that consumer income does not represent other factors, not introduced in the formula, by proxy. It may well be that the relationship shows not only the effect of the purchasing power of consumers but also the effect of other factors whose variations parallel those of consumer income. The passenger rate relationship in panel 3—obtained by plotting the value of the factor (real passenger rates $^{-0.522}$) against real passenger rates—shows that if passenger rates decrease by 100 percent, then passenger traffic could be expected to increase by 52.2 percent, but this may not necessarily represent the effect of passenger rates alone. It would not be the case, for instance, if concomitant with each decrease in passenger rates, railroad companies also attracted customers by giving faster and more comfortable service. In such a case, it would be difficult if not impossible to determine how much of the resulting increase in passenger traffic is due to the rate change or to the greater appeal of railroad travel. From this example, it is obvious that much care must be used in making statements relative to cause and effect association from the analysis.

The effect of the time factor shown in panel 4 is markedly downward—an annual average rate of decline in passenger traffic of 7.3 percent is indicated over the period considered, all other factors being equal. The time relationship represents, by proxy, the trends of a number of factors such as the increase of automobile travel, and the increase in the number of highways connecting different parts of the country. The use of a time factor makes the formula risky for purposes of extrapolation since the combined trends in the proxy factors which it represents might suddenly change.

Summarizing, cause and effect statements can be made with some degree of reliability from the results of a correlation analysis if the factors used explain most of the variation and are known to represent no other major factors (measurable or nonmeasurable) by proxy, and if the slopes of the relationships are reliable.

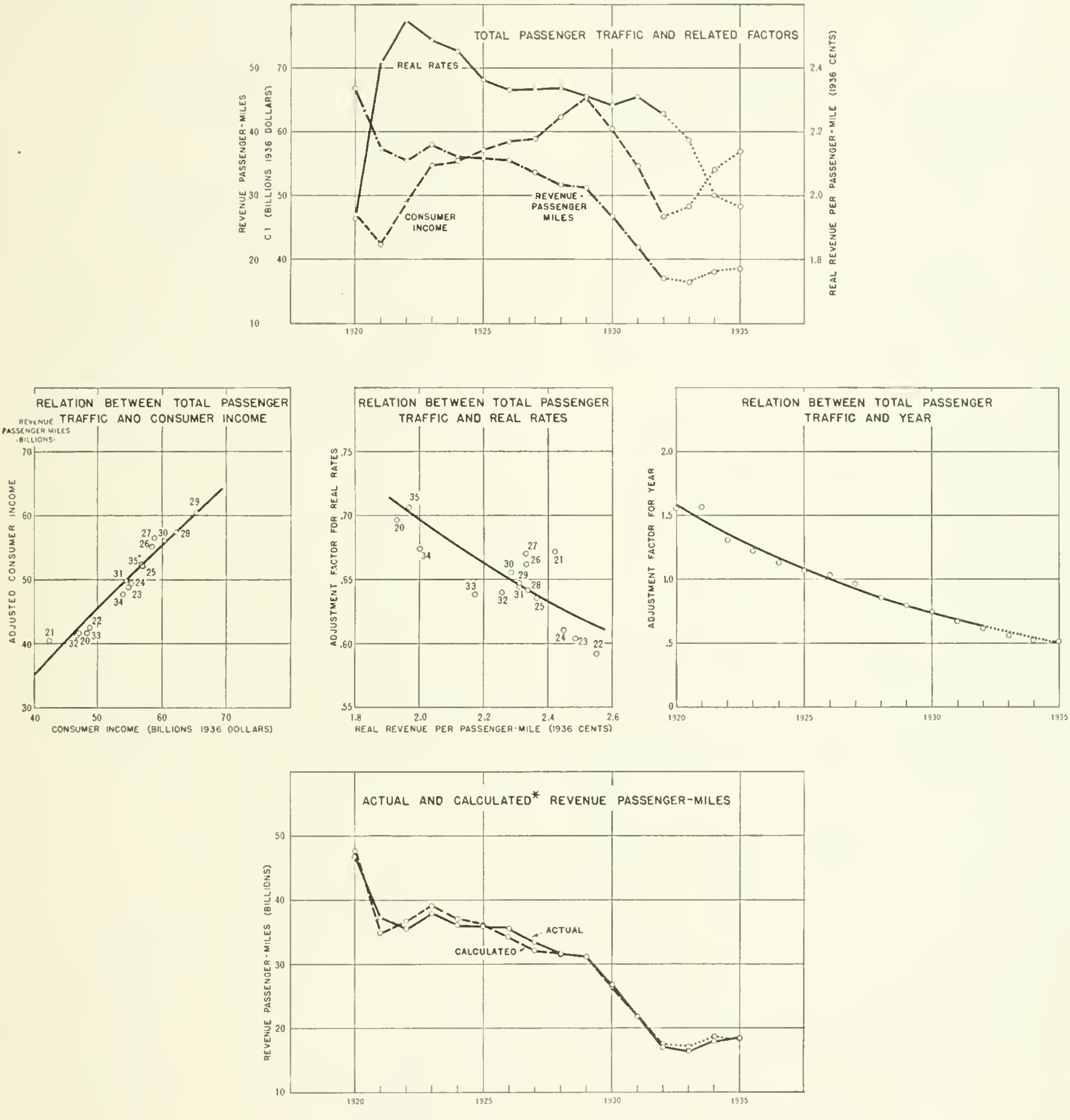
The values of consumption and employment given in table II of the body of the report are calculated for the most part from the formulas given in the summaries. In those cases where the percentage residuals are large, new analyses were made using all of the available data. For the clearly discontinuous cases such as government and banking and finance, the extrapolations were made from formulas derived for shorter periods—such as 1929–36, or in other cases a single trend value was taken for all assumed levels of consumer income in 1938.

Many of the textile analyses offered considerable difficulty and the results appear to be less reliable in general than those of the other segments. This does not necessarily imply that discontinuities are present in the textile segments, but that not enough time was available to make a careful study of the factors influencing the fluctuations in consumption of textile products, particularly the short time cyclical variations. Furthermore, data on the consumption of textiles are not directly available and the data used are therefore only approximations. Also, the factors influencing consumption are complicated and often difficult to measure—styles and fashions change and such changes cannot be properly measured. For these reasons, the results of the analyses of some of the textile segments are not considered very reliable.

The construction segment is another which involved considerable difficulty. It was originally planned to study several divisions of the construction segment—such as residential, industrial, and commercial construction.

CHART A

TOTAL PASSENGER TRAFFIC AS RELATED TO CONSUMER INCOME AND REAL RATES



*CALCULATED REVENUE PASSENGER-MILES IS GIVEN BY THE PRODUCT OF THE THREE RELATIONSHIP VALUES.

However, most of the available data on these segments were unreliable or not suitable for the purpose of the study. The total construction segment was finally used. An estimate of total value of new construction was made and a rough analysis was obtained relating output to consumer income and real construction costs. The results were not very reliable and were used only to calculate values of output to be used in extrapolating for the manpower requirements. The construction manpower analysis is given in the summary section to indicate the type of data used—the results of this analysis, however, do not appear to be too unreliable.

The study of the agriculture segment is also not satisfactory. The data on agricultural equivalent full-time employment supplied by the Bureau of Foreign and Domestic Commerce is in process of revision. The National Research Project of the Works Progress Administration, with the cooperation of the Department of Agriculture, has derived a more reliable series on persons engaged in agriculture over a long period of years. However, for the purposes of this report it was necessary to use a series on equivalent full-time employment and time did not permit the making of the necessary adjustments to convert the series of the Works Progress Administration into equivalent full-time employment. The equivalent full-time employment for agriculture for all assumed levels of income in 1938 was taken to be the same as in 1936. The error in assuming this, however, is not great, since the number of persons engaged in agriculture fluctuates but little, the maximum percent difference in employment from 1929 to the lowest point since that year (in 1932) being only 2.8 percent of the 1929 value.

TABLE I.—*General factors used in the manpower and consumption analyses*

Year	Consumer income[1] (billions of current dollars)	Index of[2] cost of living (1936=100)	Consumer[3] income (billions 1936 dollars)	Index of[4] industrial production (1923–25=100)	Index[5] of all commodity wholesale prices (1926=100)	Midyear[6] population estimates of the United States (millions)	Total[7] employment, full-time equivalent (millions)
1919	[8] 57.3	123.0	46.6	83	138.6	105.0	42.0
1920	66.8	142.0	47.0	87	154.4	106.5	42.3
1921	53.9	127.5	42.3	67	97.6	108.2	38.5
1922	57.9	118.7	48.8	85	96.7	109.9	39.9
1923	66.5	121.3	54.8	101	100.6	111.5	42.7
1924	67.3	121.5	55.4	95	98.1	113.2	42.4
1925	70.9	124.4	57.0	104	103.5	114.9	43.1
1926	73.3	125.8	58.3	108	100.0	116.5	44.4
1927	73.2	124.3	58.9	106	95.4	118.2	44.6
1928	75.8	121.9	62.2	111	96.7	119.9	45.0
1929	79.3	121.5	65.3	119	95.3	121.5	46.6
1930	71.9	119.0	60.4	96	86.4	123.1	44.6
1931	59.4	108.7	54.6	81	73.0	124.1	41.1
1932	45.9	98.3	46.7	64	64.8	125.0	37.6
1933	44.6	92.6	48.2	76	65.9	125.8	37.9
1934	51.8	95.9	54.0	79	74.9	126.6	40.3
1935	55.9	98.2	56.9	90	80.0	127.5	41.4
1936	63.9	100.0	63.9	105	80.8	128.3	43.5
1937[9]	70.0	103.2	68.0	110	86.3	129.3	45.5

NOTE.—The following preliminary and unpublished data based upon estimates of the National Research Project, Works Progress Administration, are included with permission of the National Research Project: Labor force (in millions) for the years 1921 through 1937, respectively, 42.6, 43.2, 44.1, 45.0, 45.7, 46.4, 47.1, 47.8, 48.6, 49.3, 49.9, 50.6, 51.2, 51.9, 52.5, 53.1, 53.7.

[1] Based upon data from National Bureau of Economic Research and U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce. Data for 1919–28 are based on the revised estimates of the National Bureau of Economic Research (Kuznets, Simon, *National Income and Capital Formation 1919–35*, p. 73; item: Aggregate Income Payments to Individuals, Third Variant) adjusted to agree with Department of Commerce data in 1929; data for 1929–36 are from Department of Commerce: "income paid out" as published in *Survey of Current Business* (U. S. Department of Commerce), June 1937, p. 12, and unpublished revised "noncorporate business savings."

[2] Derived from Bureau of Labor Statistics Cost of Living Index: *Changes in Cost of Living* (U. S. Department of Labor, Bureau of Labor Statistics, serial No. R–510). When only December and June values are available, the current year figure is obtained by weighting previous year's December figure by 1, current June figure by 2 and current year's December figure by 1.

[3] Data in first column divided by data in third column.

[4] Board of Governors of the Federal Reserve System, *Federal Reserve Bulletin*, October 1937, p. 1032.

[5] U. S. Department of Labor, Bureau of Labor Statistics, *Wholesale Prices*, serial No. R–205.

[6] U. S. Department of Commerce, Bureau of the Census. Data published annually in *Statistical Abstract of the United States*.

[7] Total employment from the National Bureau of Economic Research (unpublished data) 1919–29; United States Department of Commerce Estimates of Persons Engaged, 1929–36. (Agricultural Employment increased 25 percent to account for unpaid family workers.)

[8] The estimates of noncorporate business savings for 1919 are very crude and will probably be revised in the near future by the National Bureau of Economic Research. A more reasonable estimate for 1919 was therefore obtained by applying to the 1920 total income paid plus noncorporate business savings the ratio of the 1919 to 1920 national income paid out.

[9] Preliminary.

In order to determine manpower and consumption at various levels of consumer income it was necessary to develop special relationships connecting the consumption to the production in a segment or the individual real price to the consumer income, etc. These special relationships whenever used are given in the footnotes of table II of the body of the report. In those segments where changes in stocks and net exports constituted less than 1 percent of the total output, consumption was assumed to be equal to production. Otherwise a relationship between consumption and production was determined to take into account the trend of the changes in stocks and net exports. Where the real price was used as a factor, the 1936 value was used for all levels of consumer income unless a definite relationship was indicated between the real price and the consumer income. In the latter event the values determined from the relationship were used for different levels of consumer income.

The data representing the general factors which were used in the analyses are presented for convenience in table I. In the summaries which follow, all reference to such general factors will be made to this table. Table II and table III which follow the summaries give the average number of wage earners for the manufacturing segments and the number of persons engaged in nonmanufacturing industries.

LIST OF SUMMARIES

Segment		Code No.
Services to the economy:		
Federal Government	manpower	1a
State and local government	manpower	2a
Banking and finance	manpower	3a
Post office	manpower	4a
	consumption	4b
Telephone	manpower	5a
	consumption	5b
Telegraph	manpower	6a
	consumption	6b
Electric power and light	manpower	7a
	consumption	7b
Manufactured gas	manpower	8a
Railroads (all classes)	manpower	9a
Total passenger traffic, class I railways.	consumption	9b
Revenue and nonrevenue ton-miles, class I railways.	consumption	9c
Fuel consumed by railroads	consumption	9d
Auto transportation	manpower	10a
Transportation, excl. auto, railroad	manpower	11a

Manufacturing:		Code No.
Butter, cheese, condensed milk, and ice cream.	manpower	101a
	consumption	101b
Meat packing	manpower	102a
	consumption	102b
Flour milling	manpower	103a
	consumption	103b
Canning and preserving	manpower	104a
	consumption	104b
Tobacco	manpower	105a
	consumption	105b
Cane sugar refining	manpower	106a
	consumption	106b
Leather (tanning and finishing)	manpower	107a
	consumption	107b
Bread and other bakery products	manpower	108a
	consumption	108b
Other foods	manpower	109a
Confectionery and chocolate	manpower	110a
	consumption	110b
Boots and shoes	manpower	111a
	consumption	111b
Other leather products than leather and boots and shoes.	manpower	112a
	consumption	112b
Woolen and worsted	manpower	113a
	consumption	113b
Cotton textiles	manpower	114a
	consumption[1]	114b
Silk and rayon	manpower	115a
	consumption	115b
Rayon yarn	manpower	116a
	consumption	116b
Knit goods	manpower	118a
	consumption	118b
Wearing apparel	manpower	119a
	consumption	119b
Dyeing and finishing	manpower	120a
Other textiles	manpower	120.1a
	consumption	120.1b
Paper and pulp	manpower	121a
	consumption	121b
Lumber and millwork	manpower	122a
	consumption	122b
Paper products	manpower	123a
	consumption	123b
Furniture and related products	manpower	124a
	consumption	124b
Miscellaneous lumber products	manpower	125a
Printing and publishing (newspapers and periodicals).	manpower	126a
	consumption	126b
Printing and publishing (book, music, and job).	manpower	126.1a
	consumption	126.1b
Printing, publishing; allied industries	manpower	126.2a
Rubber tires and tubes	manpower	127a
	consumption	127b
Rubber products, other than tires and tubes.	manpower	128a
	consumption	128b
Chemicals	manpower	129a
	consumption	129b
Paints and varnish	manpower	129.1a
	consumption	129.1b
Petroleum refining	manpower	131a
	consumption	131b
Gasoline	consumption	131c
Glass	manpower	132a
	consumption	132b

[1] Mill consumption of raw cotton.

Manufacturing—Continued.		Code No.
Cement	manpower	133a
	consumption	133b
Clay products, other than pottery	manpower	134a
	consumption	134b
Pottery	manpower	134.1a
	consumption	134.1b
Marble, granite, other glass products	manpower	134.2a
Fertilizer	manpower	135a
	consumption	135b
Coke	manpower	136a
Industrial	consumption	136b
Domestic	consumption	136c
Iron and steel	manpower	137a
	consumption	137b
Nonferrous [2] metals excl. copper	manpower	138a
Lead	consumption	138b
Zinc	consumption	138c
Nonferrous metals other than copper, lead, and zinc.	consumption	138d
Copper smelting and refining	manpower	138.1a
	consumption	138.1b
Iron and steel products	manpower	139a
	consumption	139b
Nonferrous metal products	manpower	140a
Automobiles.[3]		
Passenger-car sales	manpower	141a
	consumption	141b
Transportation equipment, other than automobiles.	manpower	143a
Electrical machinery	manpower	144a
Machinery excluding electrical	manpower	145a
	consumption	145b
Miscel. manufacturing industries	manpower	146a
Mining:		
Petroleum, oil, and gas wells drilled	manpower	201a
	consumption	201b
Bituminous coal	manpower	202a
	consumption	202b
Anthracite coal	manpower	203a
	consumption	203b
Other nonmetallic mining	manpower	204a
	consumption	204b
Iron ore mining	manpower	205a
	consumption	205b
Nonferrous metallic mining	manpower	206a
	consumption	206b
Bulk distribution and construction:		
Wholesale trade	manpower	301a
Business service	manpower	302a
Retail trade	manpower	401a
Construction	manpower	500a
Services to the consumer:		
Public school	manpower	601a
Private school	manpower	602a
Professional service	manpower	603a
Personal service	manpower	604a
Domestic service	manpower	605a
Recreation and amusement	manpower	606a
Miscellaneous services	manpower	607a
Miscellaneous:		
Miscellaneous industries	manpower	800a
Salaried workers and entrepreneurs in mining and manufacturing.	manpower	801a
Agriculture		900a
Value of imports		1000

[2] Smelting and refining.

[3] For commercial car sales see footnote 55 of table II of the text.

Summary No. 1a
Federal Government (Excluding Post Office)—Manpower

Method used.—Federal Government employment excluding post office workers went to a high level during and after the World War period. The analysis was carried out for the years of the period 1922–32. For the period 1922–25 an adjustment in the employment was made for the effect of the World War. It appeared that normal conditions in Government employment were reached at about 1926. The factors related to employment were the average of consumer income of the preceding 3 years and time.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Actual employment [1] (thousands)	Adjusted employment [2] (thousands)	Consumer income average past 3 years [3] (billions 1936 dollars)
1919	1,620	----------	----------
1920	809	----------	----------
1921	748	----------	----------
1922	592	486	45.3
1923	562	602	46.0
1924	565	505	48.6
1925	563	529	53.0
1926	550	550	55.7
1927	549	549	56.9
1928	560	560	58.1
1929	580	580	59.8
1930	590	590	62.1
1931	599	599	62.6
1932	587	587	60.1
1933	586	586	53.9
1934	677	677	49.8
1935	790	790	49.6
1936	900	900	53.0

[1] Federal Government, regular and nonregular, excluding post office and work relief: Data for 1919–28, National Bureau of Economic Research unpublished data adjusted to Department of Commerce data. Data for 1929–36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] Employment in the civil service, excluding the employment in those agencies which were most affected by the World War, i. e., White House, State, Treasury, War, Navy, Labor, Shipping Board, Railroad Administration, Alien Property Custodian, Superintendent of State, War, and Navy Buildings, Veterans' Bureau, Railroad Labor Board, and the Civil Service Commission, as reported by the Civil Service Commission for the years 1920–37, is spliced to the adjusted National Bureau of Economic Research series at 1927 to obtain a series of employment adjusted to eliminate World War effects for 1920–25. The series thus used to extrapolate backwards amounted to 14.2 percent of the total, the assumption being made that had it not been for the war, employment in the agencies mentioned above would have varied proportionally with this sample.

[3] 3-year average of data in table I.

The formula.—The formula obtained using the adjusted data for the years 1922–25 and the actual data for the years of the period 1926–32 is:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 119.8\ (1.008)^{\text{year}-1927} \times \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income average of past 3 years})}^{0.3795}$$

The average residual for the period 1922–32 is 0.7 percent, with the maximum of 1.2 percent occurring in 1922.

The average residual for the years of the extrapolated period, 1933–36, is 29.5 percent, with the maximum of 54.6 percent occurring in 1936.

The amount of variation explained is 98 percent.

Summary No. 2a
State and Local Government—Manpower

Method used.—The factors related to employment were the average of consumer income of the current and 2 preceding years, and time, for the years of the period, 1921–32. In this case the graphical analysis indicated that the linear formula would give a better fit than the exponential formula, and the analysis is based on the linear formula.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment [1] (thousands)	Consumer income average [2] of current and 2 preceding years (billions of 1936 dollars)
1921	959	45.3
1922	972	46.0
1923	1,018	48.6
1924	1,081	53.0
1925	1,086	55.7
1926	1,124	56.9
1927	1,160	58.1
1928	1,210	59.8
1929	1,237	62.1
1930	1,278	62.6
1931	1,251	60.1
1932	1,237	53.9
1933	1,187	49.8
1934	1,208	49.6
1935	1,241	53.0
1936	1,293	58.3

[1] Data for 1921–28, National Bureau of Economic Research unpublished adjusted to Department of Commerce data. Data for 1929–36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] 3-year average of data in table I of this Appendix.

The formula.—The formula obtained using the data for the years of the period 1921–32 is:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 574 + 10 \times \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income average of current and 2 preceding years})} + 16.76224\ (\text{year} - 1926)$$

The average residual for the period 1921–32 is 1.1 percent, with the maximum, −2.5 percent, occurring in 1925.

The average residual for the extrapolated period, 1933–36, is 1.0 percent, with the maximum, −2.4 percent, occurring in 1936.

The amount of variation explained is 98 percent.

Summary No. 3a
Banking, Real Estate and Insurance—Manpower

Method used.—The graphical analysis for the banking and finance segment indicated that when employment was related to consumer income and a time trend, a fairly satisfactory fit was obtained for the period ending in 1932, but that after 1932 the extrapolations were considerably out of line. This is an example of discontinuity and the probable explanation is that the actual employment after 1932 was much lower than the calculated employment because of the reorganization of the banking and financial system which occurred.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment[1] (thousands)	Consumer income average of current and previous year[2] (billions of 1936 dollars)
1923	819	51.8
1924	877	55.1
1925	904	56.2
1926	982	57.6
1927	1,051	58.6
1928	1,113	60.6
1929	1,185	63.8
1930	1,150	62.8
1931	1,095	57.5
1932	1,044	50.6
1933	996	47.4
1934	1,041	51.1
1935	1,097	55.4
1936	1,123	60.4

[1] Based on the estimates of the U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, for the period 1929–36; the estimates of the National Bureau of Economic Research for the years 1923–29 were spliced to the Department of Commerce estimates at 1929. Excludes "brokerage" and "building and loan" employees.

[2] Based on data given in table I of this Appendix.

The formula.—The formula derived from the data for the years 1923–32 is given by:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 26.73\,(1.029)^{\text{year}-1928} \times \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income average current and previous year})}^{0.902}$$

The average residual for the period 1923–32 is 1.9 percent; the maximum of 3.0 percent occurring in 1928.

The average residual for the extrapolated period 1933–36 is 8.3 percent with the maximum at 1936, i. e., −17.1 percent.

The percent of variation explained is 95 percent.

Summary No. 4a
Post Office—Manpower

Method used.—Employment appears to be more closely related to the deflated revenue of the preceding year than to the current year's output. Current employment was related to the deflated revenue lagged one year and to a time trend.

The data. The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment[1] (thousands)	Deflated revenue preceding year[2] (millions of 1929 dollars)
1919	236	409
1920	245	462
1921	252	473
1922	250	495
1923	256	530
1924	264	576
1925	271	608
1926	275	640
1927	277	667
1928	279	678
1929	282	690
1930	283	701
1931	282	681
1932	278	622
1933	270	518
1934	264	461
1935	260	495
1936	267	527

[1] A weighted average of post office employment on June 30 and December 31 each year, as reported by the Civil Service Commission (June 30 × 2 and December 31 × 1).

[2] *Annual Reports of the Postmaster General and Postage Rates 1789–1930* (Office of the Third Assistant Postmaster General). Gross revenue was divided by index of postal rates. The index of postal rates is a weighted arithmetic mean of percentage relatives of various classes of mail with year 1929 as base. Weights are proportional to revenue derived in the base year. The fiscal year data were converted to a calendar year basis by taking a 2-year moving average.

The formula.—The following formula was derived, using the data for the years of the period 1919–32:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} =$$

$$47.3\,(1.003)^{\text{year}-1926}\,\underset{\text{(Millions of 1929 dollars)}}{(\text{deflated output preceding year})}^{0.2716}$$

The average residual for the period 1919 32 is 0.4 percent, with the maximum of 1.4 percent occurring in 1921.

The average residual for the extrapolated period 1933 36 is 1.6 percent, with the maximum of 3.0 percent occurring in 1934.

The amount of variation explained is 98.5 percent.

Summary No. 4b
Post Office—Output

Method used: Revenues of the post office, deflated by postal rates, were related to an average of the current and previous year's consumer income, an index of postal rates deflated by cost of living, and a time trend. An exponential form was first used, and the influence of the rate factor later changed from the exponential form to a linear factor.

The data.—The following table gives the data used in the analysis:

Output and related factors

Year	Deflated revenue[1] (millions of 1929 dollars)	Consumer income, 2-year average[2] (billions of 1936 dollars)	Deflated index of postal rates[3]
1922	530	45.6	80.9
1923	576	51.8	79.1
1924	608	55.1	79.3
1925	640	56.2	79.0
1926	667	57.6	80.0
1927	678	58.6	81.7
1928	690	60.6	82.7
1929	701	63.8	82.3
1930	681	62.8	84.0
1931	622	57.5	92.0
1932	518	50.6	117.8
1933	461	47.4	137.6
1934	495	51.1	128.4
1935	527	55.4	125.2
1936	562	60.4	122.9

[1] *Annual Reports of the Postmaster General and Postage Rate—1789–1930* (Office of the Third Assistant Postmaster General). Gross Revenue was divided by index of postal rates. (See Summary No. 4a.)

[2] Average of current and previous year based on data given in table I of this Appendix.

[3] Index of postal rates (1929=100). See Summary No. 4a. This was deflated by cost of living index (1936=100) as given in table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1922–32:

$$\underset{\text{(Millions of 1929 dollars)}}{\text{Calculated deflated revenue}} =$$

$$143.5\,(1.005)^{\text{year}\ 1927} \times \left(\begin{matrix}\text{(consumer income, average}\\ \text{of current and past year)}\\ \text{(Billions of 1936 dollars)}\end{matrix}\right)^{0.8161} \times$$

$$(\text{Index of deflated rates})^{-0.392} \qquad (1)$$

This was modified[1] by substituting a linear factor for price:

$$\underset{\text{(Millions of 1929 dollars)}}{\text{Calculated deflated revenue}} =$$

$$143.5\,(1.005)^{\text{year}-1927} \times \left(\begin{matrix}\text{(consumer income, average}\\ \text{of current and past year)}\\ \text{(Billions of 1936 dollars)}\end{matrix}\right)^{0.8161} \times$$

$$(1.458 - 0.00457\ (\text{index of deflated rates})) \qquad (2)$$

Using formula (2) the following results are obtained:

The average residual for the years covered in the analysis, 1922–32, is 1.9 percent, with a maximum of 2.9 percent occurring in 1927.

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[1] For a description of the method see ch. V of Appendix 1.

The average residual for the extrapolated years, 1933–36, is 3.0 percent, with a maximum of 6.0 percent occurring in 1933.

The amount of variation explained is 94 percent.

Summary No. 5a
Telephone—Manpower

Method used.—The factors related to manpower are the average of the current and past year output and a time trend. The output relationship was subsequently modified by using the method of selected points.

The data.—The following table gives the data used in the analysis for the years of the period 1921–32:

Manpower and related factors

Year	Persons engaged [1] (thousands)	Telephone output [2] (1920=100)	Index of output average current and past year [3] (1920=100)
1921	286	107.2	103.6
1922	305	118.6	112.9
1923	333	128.0	123.3
1924	340	135.0	131.5
1925	352	143.7	139.3
1926	360	153.3	148.5
1927	367	161.2	157.3
1928	383	171.3	166.2
1929	427	185.0	178.2
1930	419	181.8	183.4
1931	369	174.5	178.1
1932	334	156.3	165.4
1933	308	145.4	150.9
1934	299	150.0	147.7
1935	292	[4] 156.4	153.2
1936	300	[4] 169.5	162.9

[1] Data for 1919-28, National Bureau of Economic Research data adjusted to Department of Commerce data; data for 1929-36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] National Bureau of Economic Research Bulletin 59, p. 24, as presented in *Technological Trends* (National Resources Committee), p. 77. Data are a weighted average of exchange and toll connections.

[3] 2-year average of data in preceding column.

[4] Extrapolated by National Resources Committee index computed from unpublished data of the Federal Communications Commission, 1926-36; average of 2 extrapolations.

The formula.—The formula obtained by using the data for the period of the years 1921–32 is as follows:

$$\underset{\text{(thousands)}}{\text{Calculated employment}} = -1403 - 9.9056^{\text{year}-1926} + 625.9\ \underset{(1920=100)}{(\text{index of output})}^{0.2063}$$

The average residual for the period 1921–32 is 2.1 percent, with the maximum of 6.0 percent occurring in 1929.

The average residual for the extrapolated period, 1933-36, is 2.7 percent, with the maximum of 5.7 percent occurring in 1934.

The amount of variation explained is 93 percent.

Summary No. 5b
Telephone—Consumption

Method used.—The factors related to telephone consumption are consumer income and a time trend. It appears that the consumer income of the past 2 years also affects the output of telephone, and so the series used consisted of a weighted average of the current and past 2 years, the weights being 2 for the current year, 2 for the previous year, and 1 for the second previous year. The exponential form of the equation was first used, but this was modified by substituting for the time trend factor an exponential with an additive constant.

The data.—The following table gives the data used in the analyses for the years of the period 1921–32:

Consumption and related factors

Year	Telephone output index [1] (1920=100)	Consumer income, weighted average of current and past 2 years (billions of 1936 dollars) [2]
1921	107.2	45.0
1922	118.6	45.8
1923	128.0	49.9
1924	135.0	53.8
1925	143.7	55.9
1926	153.3	57.2
1927	161.2	58.3
1928	171.3	60.1
1929	185.0	62.8
1930	181.8	62.7
1931	174.5	59.0
1932	156.3	52.6
1933	145.4	48.9
1934	150.0	50.2
1935	[3] 156.4	54.0
1936	[3] 169.5	55.1

[1] National Bureau of Economic Research Bulletin 59, p. 24, as presented in *Technological Trends* (National Resources Committee) p. 77. Data are a weighted average of exchange and toll connections.

[2] Computed from data in table I of this Appendix; current year consumer income weighted by 2, previous year weighted by 2, and the second previous year weighted by 1.

[3] Extrapolated by National Resources Committee index computed from Federal Communications Commission data, 1926-36; average of 2 extrapolations.

The formula.—The formula obtained by using the data for the period of the years 1921–32 is as follows:

$$\underset{(1920=100)}{\text{Calculated telephone output}} = 2.814\{1.158 - 0.1138\ (0.8948)^{\text{year}-1929}\} \times \underset{\text{(Billions of 1936 dollars)}}{(\text{weighted consumer income})}^{1.0434}$$

The average residual for the period 1921–32 is 1.9 percent with the maximum of −4.7 percent occurring in 1924.

The average residual for the extrapolated period, 1933–36 is 1.4 percent, with the maximum of −3.8 percent occurring in 1935.

The amount of variation explained is 97.5 percent.

Summary No. 6a
Telegraph—Manpower

Method used.—Employment is related to the operating revenues of the current and previous years and a time trend. An exponential relationship was first fitted to the data for 1920–32, and a free-hand curve was later substituted for the logarithmic form (ignoring 1920). A formula was then fitted to this curve by the selected point method.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment [1] (thousands)	Operating revenues in millions of current dollars [2]	
		Current year	Previous year
1920	76.9	141.1	122.1
1921	72.9	124.9	141.1
1922	69.8	127.8	124.9
1923	73.9	134.4	127.8
1924	76.4	136.1	134.4
1925	81.6	152.9	136.1
1926	85.7	161.1	152.9
1927	83.4	158.9	161.1
1928	85.6	165.0	158.9
1929	96.2	175.6	165.0
1930	94.1	158.9	175.6
1931	81.1	134.8	158.9
1932	68.3	104.4	134.8
1933	65.5	103.0	104.4
1934	71.8	108.2	103.0
1935	69.8	112.0	108.2
1936	74.1	122.1	112.0

[1] 1920–28, unpublished data of the National Bureau of Economic Research adjusted to Department of Commerce data; 1929-36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] Federal Communications Commission, unpublished data. Includes only the operations of Western Union and Postal Telegraph.

The formula.—The following formula was derived from the data for the period 1921–32:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = \{55.82 + 5.455 \times (1.1094)^{\text{year}-1929}\}\underset{\text{(100 millions of dollars)}}{(\text{operating revenues current year})}^{0.5373} \times \underset{\text{(100 millions of dollars)}}{(\text{operating revenues previous year})}^{0.2598}$$

The average residual for the years covered in the analysis, 1921–32, is 2.1 percent, with the maximum of −4.0 percent occurring in 1927.

The average residual for the extrapolated years, 1933–36, is 2.7 percent, with the maximum of 5.4 percent occurring in 1934.

The amount of variation explained is 98 percent.

Summary No. 6b
Telegraph—Consumption

Method used.—Telegraph output is related to the consumer income, an average of the real cost per message for the current and previous year, and a time trend. An exponential relationship was fitted to the data for 1919–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Output [1] (million messages)	Consumer income [2] (billions of 1936 dollars)	Real cost per message: Average current and previous year [3] (1936 cents)
1919	163.2	46.6	60.8
1920	187.8	47.0	56.8
1921	173.5	42.3	54.6
1922	166.2	48.8	60.6
1923	191.0	54.8	61.4
1924	189.6	55.4	58.5
1925	206.3	57.0	59.3
1926	221.6	58.3	58.7
1927	220.1	58.9	58.0
1928	229.3	62.2	58.6
1929	239.8	65.3	60.1
1930	217.2	60.4	60.8
1931	189.3	54.6	63.4
1932	147.6	46.7	68.8
1933	148.5	48.2	73.4
1934	160.4	54.0	72.6
1935	169.8	56.9	68.8
1936	187.3	63.9	66.2

[1] Federal Communications Commission, unpublished data. A revised series on messages available only for 1926–36 was extended back to 1919 by splicing at 1926 a cruder series on number of messages, from the same source. Data include Western Union and Postal Telegraph only.

[2] See table I of this Appendix.

[3] Based upon unpublished data from Federal Communications Commission. Cash per message obtained by dividing operating revenues by number of messages. This series was then deflated by the Bureau of Labor Statistics cost of living index and an average of current and previous year taken.

The formula.—The following formula was obtained from the data for the years 1919–32:

$$\underset{\text{(Billion messages)}}{\text{Calculated output}} = 1.5357\ (1.006)^{\text{year}-1926} \times \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})}^{0.8765}\underset{\text{(1936 cents)}}{(\text{real cost per message, 2-year average})}^{-1.3577}$$

The average residual for the years covered by the analysis, 1919–32, is 1.9 percent, with a maximum of −7.3 percent occurring in 1924.

The average residual for the extrapolated years, 1933–36, is 5.9 percent, with a maximum of −11.0 percent occurring in 1936.

The amount of variation explained is 95 percent.

Summary No. 7a
Electric Power and Light—Manpower

Method used.—The factors which were related to man-hours are production in kilowatt-hours and a time trend. The average of the current year and previous year's production is used, since it is believed that the change in employment does not respond immediately to a change in production but rather to a trend in the change in production. A different relationship seems to hold for the years previous to 1923. For the purposes of this analysis, only data for the years after 1922 were considered.

The data.—The following tables gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (millions)	Production [2] (billions of kilowatt-hours)
1923	8.90	51.7
1924	9.62	57.4
1925	9.96	62.4
1926	11.03	69.8
1927	11.74	77.0
1928	12.78	84.0
1929	13.97	92.6
1930	14.44	96.6
1931	13.46	93.8
1932	10.87	87.4
1933	9.83	84.2
1934	10.07	88.3
1935	9.96	95.3
1936	10.65	106.4

[1] Computed by multiplying employment by average hours per week. Employment from National Bureau of Economic Research unpublished data, 1923–28; 1929–36 from Department of Commerce, Bureau of Foreign and Domestic Commerce, average hours per week from National Industrial Conference Board, *Wages and Hours in the United States*, 1914–36, p. 162; 1924 data interpolated by straight line.

[2] Computed from data published in Survey of Current Business U. S. Department of Commerce). 1936 Annual Supplement and recent monthly issues. Compiled by U. S. Department of Interior, Geological Survey (after May 1936, by the Federal Power Commission). Data are the average of current year's and preceding year's production.

The formula.—The following formula was derived by using the data for the years of the period 1923–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours}} = 0.03672\{-0.690 + 1.6934\ (0.9701)^{\text{year}-1926}\} \times \underset{\text{(Billions of kilowatt-hours)}}{(\text{production average current and previous year})}^{1.3466}$$

The average residual for the period 1923–32 is 2.1 percent, with the maximum of 5.9 percent occurring in 1931.

The man-hours for the years 1933–36 were extrapolated from the formula. The average residual for these 4 years is 2.4 percent, with the maximum of −3.4 percent occurring in 1936.

The amount of variation explained is 95 percent.

Summary No. 7b
Electric Power—Consumption

Method used.—The factors which are related to the consumption of electric power are consumer income, industrial production, and a time trend. Industrial production is related to that part of the electric power consumed by industrial users; the consumer income is related to that part of the electric power consumed for domestic and commercial purposes. The consumer income of the previous year also appears to have some influence on the consumption of electric power; thus, an average of consumer income of the current year and the previous year was one of the factors used. The graphical analysis indicated that a linear formula gave a much better fit than the exponential formula.

The data.—The data used in the analysis are as follows:

Consumption and related factors

Year	Consumption[1] (billions kilowatt-hours)	Industrial production[2] (1923–25=100)	Consumer income, average of current and previous year[3] (billions 1936 dollars)
1920	43.6	87	46.8
1921	41.0	67	44.6
1922	47.7	85	45.6
1923	55.7	101	51.8
1924	59.0	95	55.1
1925	65.9	104	56.2
1926	73.8	108	57.6
1927	80.2	106	58.6
1928	87.9	111	60.6
1929	97.4	119	63.8
1930	95.9	96	62.8
1931	91.7	81	57.5
1932	83.1	64	50.6
1933	85.4	76	47.4
1934	91.2	79	51.1
1935	99.4	70	55.4
1936	113.5	105	60.4

[1] Survey of Current Business (U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce), 1936 Supplement, p. 85. This is annual production of electric power compiled by the United States Department of the Interior, Geological Survey (after May 1936 by the Federal Power Commission).

[2] Federal Reserve Board. See table 1 of this Appendix.

[3] Based on data in table I of this Appendix.

The formula.—The following formula based on the data for the period of the years 1920–32 was derived:

$$\underset{\text{(Billions kilowatt-hours)}}{\text{Calculated consumption}} =$$

$$1.81+3.558\ (\text{year}-1926)+0.09258\ \underset{(1923\text{–}25=100)}{(\text{industrial production})}+$$

$$1.1047\ \underset{\text{(Current and previous year)}}{(\text{average of consumer income})}$$

The average residual for the years of the period 1920–32 is 3.6 percent; the maximum, 8.5 percent, occurs in 1920.

The average residual for the extrapolated period 1933–36 is 2.0 percent; the maximum, −3.9 percent, occurs in 1935.

The amount of variation explained is 97.5 percent.

Summary No. 8a
Manufactured Gas—Manpower

Method used.—Employment in manufactured gas was related directly to consumer income and a time trend by using linear multiplicative factors. The character of the relationship appears to have altered radically since 1928 due to the fact that natural gas has been increasing in use. The analysis was therefore considered for the years 1929–34. The 1933 and 1934 data were included because of the small number of observations.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment[1] (thousands)	Consumer income[2] (billions 1936 dollars)
1929	64.6	65.3
1930	59.6	60.4
1931	53.4	54.6
1932	41.8	46.7
1933	47.5	48.2
1934	50.5	54.0
1935	51.0	56.9
1936	54.3	63.5

[1] Total equivalent full time employed, Bureau of Foreign and Domestic Commerce, Department of Commerce.

[2] See table I of this Appendix.

The formula.—The formula derived for the years of the period 1929–34 was:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} =$$

$$\{1.066-0.0209\ (\text{year}-1929)\}\ \{6.4+0.833\ \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})}\}$$

The average residual for the period 1929–34 is 1.8 percent, with the maximum of 3.9 percent occurring in 1933.

The average residual for the extrapolated years is 1.0 percent, with the maximum of 1.0 percent occurring in 1935.

The amount of variation explained is 95 percent.

Summary No. 9a
Railroad Transportation—Manpower

Method used.—Man-hours was expressed by a linear relation involving freight traffic (revenue and nonrevenue net ton-miles), passenger traffic (revenue passenger-miles), and a time trend using the data for the years 1919–32. Analysis of employment classifications indicated that as much manpower was absorbed for every passenger-mile as for every 5 ton-miles, and these two factors were therefore combined in these proportions.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employee-hours (millions)	Net ton-miles, revenue and nonrevenue (billions)	Revenue passenger-miles (billions)
1919	5,030	395	46.4
1920	5,450	449	46.8
1921	4,150	345	37.3
1922	4,310	376	35.5
1923	4,930	458	38.0
1924	4,530	430	36.1
1925	4,530	456	36.0
1926	4,670	489	35.5
1927	4,520	475	33.6
1928	4,310	477	31.6
1929	4,350	492	31.1
1930	3,760	422	26.8
1931	3,040	340	21.9
1932	2,380	259	17.0
1933	2,230	275	16.3
1934	2,390	298	18.0
1935	2,400	312	18.5
1936	2,680	373	22.4

Source: *Statistics of Railways in the United States* (Interstate Commerce Commission), for the respective years.

The formula.—The following formula was derived by correlation analysis for the years of the period 1919–32:

$$\underset{\text{(10 millions)}}{\text{Calculated employee-hours}} =$$

$$69.7-7.75\ (\text{year}-1926)+0.60322\ \underset{\text{(Billions)}}{(\text{net ton-miles})}+$$

$$3.0161\ \underset{\text{(Billions)}}{(\text{revenue passenger-miles})}$$

The average residual for the period 1919–32 is 1.3 percent, with the maximum residual of −3.3 percent for the year 1921.

The average residual for the years of the extrapolated period 1933–36 is 2.9 percent, with the maximum of −6.0 percent occurring in 1936.

The amount of variation explained is 99.5 percent.

Summary No. 9b
Railroad Transportation—Passenger Traffic

Method used.—The three principal factors which were related to the passenger-miles output of railroads are: (1) Consumer income, (2) real passenger rates, and (3) a time trend. Fairly good relationships were obtained between noncommuting traffic and these three factors and between commuting traffic and the three factors. However, it was decided to obtain a relationship involving total revenue passenger traffic. Total revenue passenger-miles was related to consumer income, passenger revenue per passenger-mile deflated by the cost of living index and a time trend.

The data.—The following table gives the data employed in the analysis:

Passenger traffic and related factors

Year	Revenue passenger-miles[1] (billions)	Consumer income,[2] (billions 1936 dollars)	Revenue per passenger-mile[3] (in 1936 cents)
1920	46.8	47.0	1.933
1921	37.3	42.3	2.420
1922	35.5	48.8	2.550
1923	38.0	54.8	2.488
1924	36.1	55.4	2.451
1925	35.9	57.0	2.362
1926	35.5	58.3	2.334
1927	33.6	58.9	2.330
1928	31.6	62.2	2.338
1929	31.1	65.3	2.311
1930	26.8	60.4	2.283
1931	21.9	54.6	2.312
1932	17.0	46.7	2.257
1933	16.3	48.2	2.174
1934	18.0	54.0	2.000
1935	18.5	56.9	1.965

[1] *Statistics of Railways in the United States* (Interstate Commerce Commission), for the respective years.
[2] See table I of this Appendix.
[3] Computed. Interstate Commerce Commission data deflated by the Bureau of Labor Statistics cost of living index (1936=100).

The formula.—The following formula was derived from the data for the years of the period 1920–32:

$$\underset{\text{(Billions)}}{\text{Calculated revenue passenger-miles}} =$$

$$0.6775\ (0.9264)^{\text{year}-1926} \times \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})}^{1.0748} \times$$

$$\underset{\text{(In 1936 cents)}}{(\text{revenue per passenger-mile})}^{-0.5221}$$

The average residual for the period 1920–32 is 2.2 percent, with the maximum of 6.6 percent occurring in 1921.

The extrapolated values for the years 1933, 1934, and 1935 are very close—the average residual for these 3 years is 2.6 percent, with the maximum of −4.1 percent occurring in 1933.

The amount of variation explained is 97 percent.

Summary No. 9c
Railroad Transportation—Freight Traffic

Method used.—Freight traffic, represented by revenue ton-miles, was first expressed by an exponential equation involving a time trend and the Federal Reserve Board's index of total industrial production. Consideration of the period between primary processing activities and shipment of finished goods suggested that the relationship could be improved by lagging the index of industrial production by a few months. The most satisfactory results were obtained when the index of industrial production for the year ended September was used. The equation was derived from the data for the years 1920–32.

The data.—The following table gives the data used in the analysis:

Freight traffic and related factors

Year	Freight traffic net revenue ton-miles[1] (billions)	Industrial production year ending September[2] (1923–25=100)
1920	410	89
1921	307	69
1922	339	79
1923	413	101
1924	388	94
1925	414	102
1926	444	107
1927	429	108
1928	433	107
1929	447	120
1930	383	102
1931	309	84
1932	234	66
1933	249	74
1934	269	79
1935	282	85
1936	339	101

[1] *Statistics of Railways in the United States* (Interstate Commerce Commission) for the respective years.
[2] *Federal Reserve Bulletins.*

The formula.—The following formula was derived by correlation analysis for the years of the period 1920–32:

$$\underset{\text{(Billions net ton-miles)}}{\text{Calculated freight traffic}} = 3.769\ (0.9804)^{\text{year}-1926} \times$$

$$\underset{(1923\text{–}25=100)}{(\text{industrial production, year ended September})}^{1.0146}$$

The average residual for the period 1920–32 is 1.6 percent, with the maximum of 4.3 percent occurring in 1928.

The extrapolated values for the years 1933–36 are very close—the average residual for these 4 years is 2.2 percent, with the maximum of −4.2 percent occurring in 1933.

The amount of variation explained is 97 percent.

Summary No. 9d
Railroad Transportation—Fuel Consumption

Method used.—The relationship between fuel consumed and passenger traffic, freight traffic, and a time trend was first expressed by a linear equation. The constants were determined by least squares using the data for the years 1920–32. Due to the high intercorrelation which exists among the factors, the coefficient of the passenger traffic factor was negative. It was therefore necessary to get a series which would be a combination of freight and passenger traffic. These two services consumed fuel in about the ratio of 1 to 4.5 respectively and this ratio was used to combine the two series. The constants were then determined from a linear equation giving fuel consumption in terms of a time trend and the equated net ton-miles series using the data for the years 1920–32. The calculated fuel consumption for the 4 years 1933–36 was derived from this equation.

The data.—The following table gives the data used in the analysis:

Fuel consumption and related factors

Year	Fuel consumption (million net tons)	Net ton-miles revenue and nonrevenue (billions)	Revenue passenger-miles (billions)
1920	151	449	46.8
1921	121	345	37.3
1922	127	376	35.5
1923	149	458	38.0
1924	136	430	36.1
1925	135	456	36.0
1926	140	489	35.5
1927	133	475	33.6
1928	130	477	31.6
1929	132	492	31.1
1930	114	422	26.8
1931	95	340	21.9
1932	78	259	17.0
1933	77	275	16.3
1934	83	298	18.0
1935	84	312	18.5
1936	98	373	22.4

Source: *Statistics of Railways in the United States* (Interstate Commerce Commission) for the respective years.

The formula.—The following formula was derived by correlation analysis for the years of the period 1920–32:

$$\underset{\text{(Millions net tons)}}{\text{Calculated fuel consumed}} = 28.0 - 1.66\ (\text{year} - 1926) +$$

$$0.1728\ \underset{\text{(Billions)}}{(\text{net ton-miles})} + 0.7774\ \underset{\text{(Billions)}}{(\text{revenue passenger-miles})}$$

The average residual for the period 1920–32 is 1.4 percent, with the maximum of 4.9 percent occurring in 1923.

The extrapolated values for the years 1933–36 are very close; the average residual for these 4 years is 3.2 percent, the maximum of 3.9 percent occurring in 1936.

The amount of variation explained is 99.2 percent.

Summary No. 10a
Auto Transportation—Manpower

Method used.—Employment in transportation by busses and trucks was related directly to an average of the consumer income for the current and the previous year and a time trend. An exponential relationship was fitted to the data for the years 1926–32.

Data used.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment [1] (thousands)	Consumer income, 2-year average [2] (billions of 1936 dollars)
1926	630	57.6
1927	659	58.6
1928	695	60.6
1929	741	63.8
1930	749	62.8
1931	722	57.5
1932	677	50.6
1933	667	47.4
1934	708	51.1
1935	755	55.4

The formula.—The following formula was obtained from the data for the years 1926–32:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 35.46\ (1.0274)^{\text{year}-1929} \times$$

$$\underset{\text{(Billions 1936 dollars)}}{(\text{consumer income average current and previous year})}^{0.73056}$$

The average residual for the years covered in the analysis, 1926–32, is 0.2 percent, with the maximum of 0.4 percent occurring in 1928.

The average residual for the extrapolated years, 1933–35, is 1.9 percent, with the maximum of −3.8 percent occurring in 1935.

The amount of variation explained is 97 percent.

Summary No. 11a
Transportation Other Than Auto and Railroad—Manpower

Method used.—The factors which were related to manpower were consumer income and a time trend. An exponential form was first used but this was revised to a form in which the consumer income relationship was linear and the time trend relationship was of an exponential type with an additive constant.

The data.—The following table gives the data used in the analysis for the years of the period 1920–32:

Manpower and related factors

Year	Employment [1] (thousands)	Consumer income [2] (billions 1936 dollars)
1920	712	47.0
1921	627	42.3
1922	658	48.8
1923	661	54.8
1924	642	55.4
1925	621	57.0
1926	630	58.3
1927	612	58.9
1928	598	62.2
1929	590	65.3
1930	557	60.4
1931	494	54.6
1932	435	46.7
1933	419	48.2
1934	441	54.0
1935	447	56.9
1936	470	63.9

[1] Data for 1920–28, National Bureau of Economic Research unpublished data adjusted to Department of Commerce data; data for 1929–36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] See table 1 of this Appendix.

The formula.—The formula obtained by using the data for the period of the years 1920–32 is as follows:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = [0.4473 + 0.6648 \times$$

$$(0.9387)^{\text{year}-1926}]\ [(5.714\ \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})} + 216)]$$

The average residual for the period 1920–32 is 1.4 percent, with the maximum of 3.2 percent occurring in 1920 and 1927.

The average residual for the extrapolated period, 1933–36, is 1.3 percent, with the maximum of −2.8 percent occurring in 1933.

The amount of variation explained is 90 percent.

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[1] 1929–35. Department of Commerce, Bureau of Foreign and Domestic Commerce. 1926–28 are the sum of separate estimates for persons engaged on busses and on trucks. Trucking employment for 1926–29 was estimated by using the number of employees per intercity truck observed in a field study as reported in *Motor Truck Transportation*, and applying this ratio to the estimated number of trucks in the segment. This number of trucks was estimated by applying to total registrations the ratio of trucks in the segment to total registrations for the period 1933–35 as estimated from data in *Motor Truck Transportation*. This series was spliced to 1 derived from Department of Commerce figures at 1929

Employment on bus transportation: The number of persons engaged was obtained by a rough adjustment of the number of employees to include other persons engaged. The number of employees was estimated from the number of busses by using the ratio of employment to busses in public carrier operations as given in *Bus Facts for 1937* for 1931–36; for 1925–30 a series on the number of revenue busses was inflated by the ratio prevailing in 1931. The number of revenue busses was obtained by dividing the amount of special bus taxes by the tax per bus as given in *Auto Facts and Figures*.

[2] Data from table I of this Appendix; average of current and previous year.

MANUFACTURING

Summary No. 101a
Butter, Cheese, Condensed Milk, and Ice Cream—Manpower

Method used.—Man-hours was related to an index of production and a time trend. A modified exponential relationship was fitted to the data for the years 1921-32.

The data.—The following table gives the data used in the final analysis:

Manpower and related factors

Year	Man-hours per week [1] (ten thousands)	Production [2] (1929=100)
1921	288	67.1
1922	302	74.4
1923	315	80.4
1924	305	82.0
1925	287	87.3
1926	292	89.7
1927	296	93.4
1928	294	93.2
1929	289	100.0
1930	266	96.9
1931	227	91.8
1932	205	80.8
1933	194	79.4
1934	211	85.3
1935	223	89.5

[1] Average hours per week for the ice cream industry were obtained from unpublished figures given in a preliminary report on *Productivity in the Ice Cream Industry*. Average hours per week for the remainder of the segment for 1929 were estimated from census data on prevailing hours and for the other years from the average hours per week for ice cream on the basis of the ratio prevailing in 1929. An average for the entire segment was then obtained weighted on the basis of 1929 employment. Employment was obtained from the Census for odd years. For 1926, 1928, and 1930 Bureau of Labor Statistics' employment indexos for ice cream were used as an interpolating medium to obtain employment for the rest of the segment. For 1924, 1932, 1934, and 1936 Bureau of Labor Statistics figures were used. The employment for the years 1920 and 1922 was obtained by linear interpolation. The index of man-hours was then obtained by multiplying employment by average hours per week.

[2] See summary 101b, footnote 1.

The formula.—The following formula was derived from the data for the years 1921-32:

$$\underset{\text{(Thousands)}}{\text{Calculated man-hours}} = 44.06\ (0.9532)^{\text{year}-1926}\ \underset{(1929=100)}{(\text{production})}^{0.9532}$$

The average residual for the years covered by the analysis, 1921-32, is 2.1 percent, with a maximum of 5.4 percent in 1928.

Man-hours for the years 1933 to 1935 were calculated from the formula. The average residual for the 3 years was 9.0 percent, with a maximum of 15.5 percent in 1935.

The amount of variation explained is 93 percent.

The employment given in table II of the text was calculated from the following formula, using all of the data for the years of the period 1921-35:

$$\underset{\text{(Thousands)}}{\text{Calculated man-hours}} = 72.86\ (0.9601)^{\text{year}-1926}\ \underset{(1929=100)}{(\text{production})}^{0.8240}$$

Summary No. 101b
Butter, Cheese, Condensed Milk, and Ice Cream—Consumption

Method used.—It appears that the consumption of dairy products and ice cream is related to the consumer income of this year as well as the level of the income of the previous year. The graphical method indicated that a simple average of the current year and previous year's consumer income gave the closest relationship. This factor and the time trend were therefore employed.

The data.—The following table gives the data used in making the analysis:

Consumption and related factors

Year	Consumption [1] (1929=100)	Consumer income, average of current year and previous year [2] (billions of 1936 dollars)
1921	67.1	44.6
1922	74.4	45.6
1923	80.4	51.8
1924	82.0	55.1
1925	87.3	56.2
1926	89.7	57.6
1927	93.4	58.6
1928	93.2	60.6
1929	100.0	63.8
1930	96.9	62.8
1931	91.8	57.5
1932	80.8	50.6
1933	79.4	47.4
1934	85.3	51.1
1935	89.5	55.4

[1] Ice cream production from *Productivity Report of the National Research Project* (preliminary). Butter, cheese, and condensed milk production based on *Census of Manufacturers* biannual data, interpolated by the apparent consumption of butter and cheese as given in the *Survey of Current Business*, 1936 supplement, p. 89. Ice cream production was weighted by 1 and dairy products by 1.19, the latter being based on averages of ratios of value added of butter and products to value added of ice cream for census years. Consumption is taken to be the same as production.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years of the period 1921-32.

$$\underset{(1929=100)}{\text{Calculated consumption}} = 2.375\ (1.004)^{\text{year}-1926} \times \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income, average of current and previous year})}^{0.8945}$$

The average residual for the years 1921-32 is 1.7 percent, with the maximum of 4.6 percent occurring in 1922.

The average residual for the extrapolated period, 1933-35 is 1.9 percent, with the maximum of 2.8 occurring in 1934.

The amount of variation explained is 95 percent.

Summary No. 102a
Meat Packing—Manpower

Method used.—Man-hours are related to production and a time trend for the years of the period 1922-32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1919	124.0	93.2
1920	110.7	83.1
1921	90.5	82.0
1922	92.1	89.4
1923	106.4	101.3
1924	101.4	103.4
1925	96.2	96.6
1926	94.9	98.7
1927	96.4	98.7
1928	98.0	101.0
1929	100.0	100.0
1930	94.1	94.8
1931	84.2	95.5
1932	76.1	88.6
1933	79.7	91.0
1934	90.9	97.6
1935	75.5	82.0

[1] *Productivity in the Slaughtering and Meat Packing Industry* (unpublished report of the National Research Project of the Works Progress Administration), p. 8. Based upon Bureau of Labor Statistics index of employment adjusted to 1935 census, and average hours data from National Industrial Conference Board, 1920-31, and Bureau of Labor Statistics, 1932-35.

[2] Op. cit., based upon census data for production and Department of Agriculture data for "total dressed weight of animals slaughtered."

The formula.—The following formula was derived from the data for the years of the period 1922–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 0.3086\ (0.98697)^{\text{year}-1926}\ \underset{(1929=100)}{(\text{production})}^{1.2535}$$

The average residual for the years of the period 1922–32 is 2.6 percent, with the maximum of 6.8 percent occurring in 1930.

The average residual for the years of the extrapolated period, 1933–35, is 5.1 percent with the maximum of 9.4 percent occurring in 1935.

The amount of variation explained is 83 percent.

Summary No. 102b
Meat Packing—Consumption

Method used.—The factors related to the consumption of meat products were real price of meat products and nonagricultural consumer income.

The data.—The following table gives the data used in the final analysis:

Consumption and related factors

Year	Meat products consumption monthly average (millions of pounds [1]	Index real price of meat [2]	Nonagricultural consumer income (1929=100) [3]
1921	852	76.9	64.5
1922	929	80.0	72.3
1923	1,053	77.5	81.1
1924	1,079	76.2	84.0
1925	1,025	91.4	87.2
1926	1,034	97.5	90.0
1927	1,047	92.4	92.3
1928	1,055	108.2	96.4
1929	1,058	110.8	100.0
1930	1,029	103.8	95.3
1931	1,043	87.9	88.9
1932	1,029	76.0	77.4
1933	1,082	67.9	77.0
1934	1,077	80.4	83.3
1935	909	116.3	86.8

[1] Consumption: Apparent consumption according to Russell as given in the *Survey of Current Business*, 1936 supplement.

[2] Bureau of Labor Statistics index of meat prices (1926=100) deflated by Bureau of Labor Statistics cost of living index (1936=100).

[3] Nonagricultural consumer income: Index of nonagricultural income as given on p. 25 of Nonagricultural Income As a Measure of Demand, Agricultural Adjustment Administration, deflated by the cost of living index of the Bureau of Labor Statistics (1929=100).

The formula.—The following formula was derived from the data for the years 1921–32:

$$\underset{\text{(Millions of pounds per month)}}{\text{Calculated consumption of meat products}} =$$

$$1105\left(\frac{\text{nonagricultural consumer income}}{100}\right)^{0.85031}\left(\frac{\text{real price}}{100}\right)^{-0.46327}$$

The average residual for the years 1921–32 was 1.1 percent, with a maximum of 2.1 percent in 1927 and 1928.

Consumption for the years 1933, 1934, and 1935 was calculated from the formula. The average residual for the 3 years was 1.9 percent, with a maximum of 2.9 percent in 1934.

The amount of variation explained is 95 percent.

Summary No. 103a
Flour Milling—Manpower

Method used.—The factors which were related to man-hours are an index of production and a time trend for the years 1921–32.

The data.—The following table gives the data used in the analysis for the years of the period 1921–32:

Manpower and related factors

Year	Production [1] (1929=100)	Man-hours [2] (1929=100)
1921	101.4	133.3
1922	105.7	135.4
1923	106.8	132.8
1924	109.4	125.8
1925	99.2	119.9
1926	101.8	115.2
1927	99.2	111.8
1928	99.7	106.5
1929	100.0	100.0
1930	100.3	88.8
1931	93.1	79.1
1932	84.3	73.7
1933	81.5	71.6
1934	83.2	71.6
1935	82.0	73.0

[1] *Productivity in the Flour and Other Grain-Mill Products Industry* (unpublished report of the National Research Project of the Works Progress Administration), p. 11. Based upon census data for production of all grain-mill products in odd years, and even years interpolated by means of Federal Reserve index of wheat flour milled.

[2] *Ibid.* Based upon Bureau of Labor Statistics index of employment and Census and Bureau of Labor Statistics data for hours per week.

The formula.—The formula obtained by using the data for the period of the years 1921–32 is as follows:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 2.225\ (0.9579)^{\text{year}-1927}\left(\underset{(1929=100)}{(\text{production})}\right)^{0.53857}$$

The average residual for the years of the period covered, 1921–32, is 3.4 percent, with the maximum of 6.3 percent occurring in 1927.

The average residual for the years of the extrapolated period, 1933–35 is 8.4 percent, with the maximum of 14.6 percent in 1935.

The amount of variation explained is 95 percent.

Summary No. 103b
Flour Milling—Consumption

Method used.—Flour consumption was related to consumer income (average of current and preceding year) and a time trend.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (1929=100)	Consumer income average of current and preceding year [2] (billions of 1936 dollars)
1922	107.8	45.6
1923	108.9	51.8
1924	109.9	55.1
1925	103.6	56.2
1926	103.7	57.6
1927	98.8	58.6
1928	100.1	60.6
1929	100.0	63.8
1930	99.4	62.8
1931	91.5	57.5
1932	89.6	50.6
1933	87.5	47.4
1934	88.4	51.1
1935	86.3	55.4

[1] This series represents the consumption of flour made from wheat and other grains. The consumption of wheat flour is reported by the *Survey of Current Business* (Russell's). The *Census of Manufactures* reports production of feedscreenings, bran, corn meal, rye, and buckwheat. It is assumed that the ratio of consumption to production of other flours is the same as the ratio for wheat flour. The ratio for wheat flour is Russell's consumption divided by *Census of Manufactures* production. This adjusted series for other grain consumption is combined with wheat flour consumption in odd years weighted by value of products with 1929=100. Even years were interpolated by the index of wheat consumption. The interpolation was based on the assumption that the ratios of the whole index to the index of wheat consumption were linearly related.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1922–32:

$$\underset{(1929=100)}{\text{Calculated consumption}}=$$

$$47.90(0.9801)^{\text{year}-1927}\left(\underset{(\text{Billions of 1936 dollars})}{\begin{matrix}\text{(consumer income average of current}\\ \text{and preceding year)}\end{matrix}}\right)^{0.18589}$$

The average residual in the period covered, 1922–32, is 1.1 percent. The maximum residual in the period covered, 1922–32, is −3.2 percent in 1927.

The average residual in the extrapolated period, 1933–35, is 1.1 percent. The maximum residual in the extrapolated period, 1932–35, is 2.2 percent in 1934.

The amount of variation explained is 92 percent.

Summary No. 104a
Canning and Preserving—Manpower

Method used.—Manpower in the canning and preserving industry is related to production and a time trend for the years of the period 1919–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-Hours [1] (1929=100)	Production [2] (1919=100)
1919	82.0	100.0
1920	(3)	(3)
1921	53.4	66.2
1922	(3)	(3)
1923	73.3	119.4
1924	65.1	112.0
1925	86.2	144.9
1926	(3)	(3)
1927	83.4	139.0
1928	(3)	(3)
1929	100.0	173.4
1930	96.6	190.4
1931	68.9	146.5
1932	51.8	122.3
1933	63.0	149.0
1934	72.4	164.1
1935	81.8	206.0
1936	79.0	205.9

[1] Average hours per week for 1919, 1921, 1923, and 1929 obtained from prevailing hours in Census on assumption that prevailing and actual hours in 1929 were equal; 1924 obtained by linear interpolation. Actual hours per week 1932–36 obtained from Bureau of Labor Statistics. Years 1930 and 1931 obtained by linear interpolation. Man-hours index derived by multiplying employment index from Bureau of Labor Statistics and Census by index of average hours.

[2] Production index for Census years obtained from Day-Thomas index (The Growth of Manufactures—Census Monograph VIII, 1928). Interpolations for even years from series on vegetable pack (unpublished figures of planning section of Agricultural Adjustment Administration).

[3] No data available.

The formula.—The following formula was derived from the data for the years of the period 1919, 1921, 1923–25, 1927, 1929–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}}=.5841\ (0.9566)^{\text{year}-1926}\ \underset{(1929=100)}{(\text{production})}^{1.0042}$$

The average residual for the years 1919 to 1932 is 6.1 percent with a maximum of 11.5 percent in 1929.

Man-hours for each of the 4 years, 1933 to 1936, were calculated from the formula. The average percent residual for the 4 years is 2.5 with a maximum of 6.6 percent in 1934.

The amount of variation explained is 89 percent.

Summary No. 104b
Canning and Preserving (Excluding Fish)—Consumption

Method used.—The consumption of canned and preserved fruits and vegetables is related to the consumer income, and a time trend. A linear relationship was fitted to the data for the years 1921–32. The graphical analysis indicated that the linear relationship gave a somewhat better fit than the exponential type of relationship.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (million pounds)	Consumer income [2] (billions of 1936 dollars)
1921	1,891	42.3
1922	2,620	48.8
1923	2,890	54.8
1924	2,931	55.4
1925	3,847	57.0
1926	3,493	58.3
1927	3,590	58.9
1928	3,822	62.2
1929	4,096	65.3
1930	4,218	60.4
1931	3,404	54.6
1932	3,282	46.7
1933	3,568	48.2
1934	3,973	54.0
1935	4,753	56.9

[1] Consumption: Total consumption of canned fruits plus total consumption of canned vegetables from preliminary reports of Program Planning Division of the Agricultural Adjustment Administration. The figures given are indicated consumption for the crop years of the various products; the crop year being different for different crops.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1921–32:

$$\underset{(\text{Million pounds})}{\text{Calculated consumption}}=$$

$$63.33\ \underset{(\text{Billions 1936 dollars})}{(\text{consumer income})}+100\ (\text{year}-1925)-333.3$$

The average residual for the years covered by the analysis, 1921–32, is 4.6 percent, with a maximum of 17.4 percent occurring in 1925.

The average residual for the extrapolated years, 1933–35, is 4.4 percent, with a maximum residual of 11.3 percent occurring in 1925.

The amount of variation explained is 88 percent.

Summary No. 105a
Tobacco—Manpower

Method used.—The factors which were related to man-hours are an index of production of tobacco products and a time trend.

The data.—The following table gives the data used in the analysis for the years of the period 1921–32:

Manpower and related factors

Year	Man-hours (millions) [1]	Production (1923–25=100) [2]
1919	7.57	82
1920	7.39	85
1921	7.16	87
1922	6.98	89
1923	6.98	96
1924	6.51	99
1925	6.26	105
1926	5.91	112
1927	6.08	118
1928	5.87	124
1929	5.41	134
1930	4.80	131
1931	4.20	123
1932	3.62	111
1933	3.34	116
1934	3.32	128
1935	3.16	135
1936	3.25	151

[1] Computed by multiplying employment by average hours per week. Employment data from *Census of Manufactures*, interpolated by Bureau of Labor Statistics index of employment. Hours per week from census prevailing hours and Bureau of Labor Statistics actual hours; data for 1920, 1922, 1924–28, 1930, and 1931 interpolated by straight line.

[2] Federal Reserve Board index of production of "tobacco products."

The formula.—The formula obtained by using the data for the years of the period 1921–32 is as follows:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours/week}} =$$

$$0.07433\ (0.9162)^{\text{year}-1927}\ \underset{(1923\text{-}25=100)}{(\text{industrial production})}^{0.9152}$$

The average residual for the years of the period 1921–32 is 2.0 percent, with the maximum of 4.6 percent occurring in 1928.

The average residual for the years of the extrapolated period, 1933–36, is 2.6 percent, with the maximum of −3.7 percent occurring in 1935.

The amount of variation explained is 97 percent.

Summary No. 105b
Tobacco—Consumption

Method used.—The factors which are related to tobacco consumption are consumer income and a time trend. The real price of tobacco was also considered in the analysis but appeared to be insignificant. The effect of real price is probably accounted for by proxy by the consumer income and time trend factors.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Tobacco consumption (1923–25=100)[1]	Consumer income, (billions 1936 dollars)[2]
1919	82	46.6
1920	87	47.0
1921	85	42.3
1922	89	48.8
1923	96	54.8
1924	99	55.4
1925	105	57.0
1926	112	58.3
1927	118	58.9
1928	124	62.2
1929	134	65.3
1930	131	60.4
1931	123	54.6
1932	111	46.7
1933	116	48.2
1934	128	54.0
1935	135	56.9
1936	151	63.9

[1] *Federal Reserve Bulletins* and mimeographed release (Board of Governors of the Federal Reservo System). Index of production of tobacco products, based upon cigars, cigarettes, and tobacco on which tax is paid.

[2] See table I of this Appendix.

The formula.—The following formula was derived by correlation analysis for the years of the period 1919–32:

$$\underset{(1923\text{-}25=100)}{\text{Calculated tobacco consumption}} =$$

$$9.561\ (1.026)^{\text{year}-1926}\ \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})}^{0.6058}$$

The average residual for the years 1919–32 is 2.4 percent, the maximum of 4.9 percent occurring in 1921.

The average residual for the extrapolated period, 1933–36, is 2.8 percent, the maximum of −3.3 percent occurring in 1933.

The amount of variation explained is 96 percent.

Summary No. 106a
Cane Sugar Refining—Manpower

Method used.—Man-hours was related to a production index and a time trend. An exponential relationship was fitted to the data for the period 1919–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours[1] (1929=100)	Production[2] (1929=100)
1919	129.2	82.2
1920	123.6	85.2
1921	112.7	73.7
1922	127.1	105.9
1923	104.0	86.6
1924	99.6	93.9
1925	100.6	105.8
1926	97.9	106.7
1927	98.9	100.2
1928	93.9	97.7
1929	100.0	100.0
1930	96.0	98.3
1931	81.5	86.6
1932	72.9	78.5
1933	67.4	77.0
1934	66.3	76.9
1935	69.7	82.3

[1] *Productivity in the Cane Sugar Refining Industry* (unpublished report of the National Research Project of the Works Progress Administration). Based upon Federal Reserve Board and Bureau of Labor Statistics indexes of employment, and upon prevailing hours data from the census and average hours per week from the Bureau of Labor Statistics.

[2] *Ibid.* Based upon census data for quantity of refined sugar produced, interpolated in intercensal years by a series of raw sugar melted compiled by Willet and Grey's *Statistical Sugar Trade Journal* and published in the *Survey of Current Business.*

The formula.—The following formula was derived from the data for 1919–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 23.7\ (0.9643)^{\text{year}-1926}\ \underset{(1929=100)}{(\text{production})}^{0.31728}$$

The average residual for the years covered by the analysis, 1919–32, is 4.4 percent, with a maximum of 9.2 percent in 1929 and 1930.

The average residual for the extrapolated years, 1933–35, is 4.7 percent, with a maximum of −7.7 percent in 1933.

The amount of variation explained is 87 percent.

Summary No. 106b
Sugar-Consumption

Method used.—The factors which were related to sugar consumption are: (1) Consumer income, (2) real retail price of sugar, and (3) time trend. In the preliminary graphical analysis it was observed that the data for 1919 and 1920 were considerably out of line with the apparent relationship curves. These were abnormal years with respect to sugar prices and the analysis was considered with the exclusion of these 2 years.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Total consumption of sugar [1] (millions of long tons)	Consumer income (billions of 1936 dollars)	Retail price of sugar [3] (1929 cents per pound)
1921	4.11	42.3	7.3
1922	5.09	48.8	6.8
1923	4.78	54.8	9.4
1924	4.85	55.4	8.4
1925	5.51	57.0	6.3
1926	5.67	58.3	5.9
1927	5.30	58.9	6.4
1928	5.54	62.2	6.3
1929	5.81	65.3	5.9
1930	5.60	60.4	5.6
1931	5.48	54.6	5.8
1932	5.21	46.7	5.9
1933	5.27	48.2	6.6
1934	5.14	54.0	6.7
1935	5.34	56.9	6.7
1936	5.52	63.9	6.6

[1] Sugar consumption represents deliveries as reported by Willett and Gray in various issues of the *Weekly Statistical Sugar Trade Journal;* imports and exports are accounted for but Willett and Gray gives very little information concerning the data; it is, however, believed to be a reliable sugar consumption series (see *Report to the President on Sugar*, No. 73, U. S. Tariff Commission).

[2] See table I of this Appendix.

[3] Computed from Bureau of Labor Statistics retail price of sugar as reported in *Survey of Current Business* (U. S. Department of Commerce) "1936 Annual Supplement," page 100, and Bureau of Labor Statistics cost of living index adjusted to a 1929 base.

The formula.—The following formula was derived by correlation analysis for the years of the period 1921–32:

$$\underset{\text{(Millions long tons)}}{\text{Calculated consumption}} = 1.268\ (1.0035)^{\text{year}-1926} \times \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})^{0.4764}} \times \underset{\text{(1929 cents)}}{(\text{retail price})^{-0.2626}}$$

The average residual for the years of the period covered, 1921–32, is 2.7 percent, with the maximum of —6.6 percent occurring in 1921.

The average residual for the years of the extrapolated period, 1933–26 is 3.7 percent, with the maximum of 5.2 percent occurring in 1933.

The amount of variation explained is 87 percent.

Summary No. 107a
Leather, Tanned, Curried and Finished—Manpower

Method used.—Man-hours in leather, tanned, curried and finished, was related to the Federal Reserve Board index of leather production for the period 1922–32, and later years were obtained by extrapolation. A set of graphically determined regression lines was used in place of the customary least squares solution.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man hours [1] (1923=100)	Leather production [2] (1923–25=100)
1922	[3] 101.7	107
1923	100.0	111
1924	87.0	94
1925	87.4	95
1926	88.8	99
1927	85.3	102
1928	84.3	98
1929	83.6	96
1930	75.3	90
1931	66.9	81
1932	56.8	70
1933	65.0	82
1934	61.4	88
1935	61.5	97

[1] National Industrial Conference Board, *Wages, Hours, and Employment in the United States, 1914–36*, pp. 116–119. Monthly averages.

[2] Federal Reserve Board.

[3] Last 6 months only.

The formula.—The formula obtained by using the data for the period of the years 1922–32 is as follows:

$$\underset{\text{(1923=100)}}{\text{Calculated man-hours}} = 31.1 + 0.57471\ \underset{\text{(1923-25=100)}}{(\text{leather production})} - 2.2988\ (\text{year}-1926)$$

The average residual for the years of the period covered, 1922–32, is 1.8 percent, with the maximum of 5.0 percent occurring in 1929.

The average residual for the years of the extrapolated period, 1933–35, is 3.5 percent, with the maximum of 4.2 percent occurring in 1933.

The amount of variation explained is 97 percent.

Summary No. 107b
Leather, Tanned, Curried and Finished—Consumption

Method used.—Value of leather available for consumption was related to an index of leather demand for the years of the period 1920–32. The index of leather demand given in the table below should be considered only as a crude approximation to the true index of demand since changes in stocks and corrections due to exports and imports have not been made. The formula given below is different from the standard power formula usually used in the analyses because the data indicated that a significantly better fit would result with the use of a modified formula.

The data.—The following table presents the data used in the analysis:

Consumption and related factors

Year	Value of leather [1] available for consumption (millions of 1926 dollars)	Leather demand [2] (1929=100)
1920	372	89.7
1921	338	75.2
1922	368	89.5
1923	423	101.7
1924	415	90.7
1925	400	95.3
1926	412	96.1
1927	429	98.7
1928	445	96.3
1929	439	100.0
1930	402	79.6
1931	337	72.1
1932	269	60.9
1933	283	64.9
1934	330	67.1
1935	351	73.7

[1] Based upon *Census of Manufactures* data for value of production of leather. Census value deflated by Bureau of Labor Statistics index of price of leather. Deflated series interpolated in 1920, 1932, and 1934 by Federal Reserve Board index of leather production; interpolated in other years by means of an index of leather consumption computed from data in the *Monthly Census of Hides and Leather*. The resulting series adjusted for exports and imports as reported in *Statistical Abstracts* and deflated by the Bureau of Labor Statistics price index. The series used in the analysis is an average of the current and preceding year.

[2] Based upon *Census of Manufactures* data. The index of demand is the deflated value of boots and shoes produced weighted by the proportion which the value of leather contained in them bore to the value of the boots and shoes produced in 1929 (0.292), plus the deflated value of other leather products weighted by the proportion which the value of leather contained in them bore to the total value of other leather products in 1929 (0.338) converted to a 1929 base. For method of obtaining the value series used, see summaries for Boots and Shoes—Manpower, footnote 2, and Leather Products Other Than Leather and Boots and Shoes—Manpower, footnote 2.

The formula.—The following formula was obtained by using the data for the years of the period 1920–32:

$$\underset{\substack{\text{(Average current and preceding year)}\\ \text{(Millions of 1926 dollars)}}}{\text{Leather available for consumption}} = 678 - \left(\frac{24{,}412}{\underset{\text{(1929=100)}}{\text{leather demand}}}\right)$$

The average residual for the years of the period covered, 1920–32, is 4.1 percent, with the maximum of —9.1 percent occurring in 1922.

The average residual for the years of the extrapolated period, 1933–35, is 4.5 percent, with the maximum of —6.3 percent occurring in 1933.

The amount of variation explained is 82 percent.

Summary No. 108a
Bread and Other Bakery Products—Manpower

Method used.—An index of man-hours was related to an index of production for the years of the period 1923–32.

Data used.—The following table presents the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1923	80.4	78.3
1924	81.3	86.0
1925	79.4	83.5
1926	81.7	90.4
1927	85.5	92.8
1928	90.6	96.4
1929	100.0	100.0
1930	95.6	99.4
1931	85.9	91.2
1932	79.1	82.7
1933	79.1	79.9
1934	84.1	87.3
1935	86.1	91.7

[1] Preliminary report on *Productivity in the Bread and Other Bakery Products Industry* (National Research Project of the W. P. A.). Based upon Bureau of Labor Statistics index of employment, adjusted to 1935 census. Hours-per-week data from census prevailing hours in 1923 and 1929, interpolated linearly in other years; for the years 1932–35 from Bureau of Labor Statistics.

[2] Loc. cit., based upon Census production data for odd years interpolated in noncensus years by a series representing wheat flour consumed in the bakery products industry.

The formula.—The formula obtained by correlation analysis of the data for the years 1923–32 is as follows:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 1.524\ \underset{(1929=100)}{(\text{production})}^{0.8959}$$

The average residual for the years of the period covered, 1923–32, is 2.7 percent, with the maximum of 5.9 percent occurring in 1923 and 1929.

The average residual for the years of the extrapolated period, 1933–35, is 1.5 percent, with the maximum of 2.6 percent occurring in 1933.

The amount of variation explained is 81 percent.

Summary No. 108b
Bread and Other Bakery Products—Consumption

Method used.—Consumption was assumed to be equal to production, and an index of production was related to consumer income and a time trend for the period 1923–32. Since the time factor contributed very little to the total variance and because a linear relationship gave satisfactory results over a period 1923–1932, the formula presented below is an additive one rather than the multiplicative type.

The data.—The following table presents the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (1929=100)	Consumer income average current and preceding year [2] (billions of 1936 dollars)
1923	78.3	51.8
1924	86.0	55.1
1925	83.5	56.2
1926	90.4	57.6
1927	92.8	58.6
1928	96.4	60.6
1929	100.0	63.8
1930	99.4	62.8
1931	91.2	57.5
1932	82.7	50.6
1933	79.9	47.4
1934	87.3	51.1
1935	91.7	55.4

[1] See footnote 2, summary 108a.

[2] See table I of this Appendix.

The formula.—The following formula was obtained by correlation analysis of the data for the years 1923–32:

$$\underset{(1929=100)}{\text{Calculated consumption}} = 2.73 + 0.588\ (\text{year} - 1928) +$$

$$1.5252\ \underset{(\text{Billions 1936 dollars})}{(\text{consumer income, avg. current and previous year})}$$

The average residual for the years of the period covered, 1923–32, is 1.3 percent, with the maximum of −3.7 percent occurring in 1925.

The average residual for the years of the extrapolated period, 1933–35, is 2.2 percent, with the maximum of 3.7 percent occurring in 1934.

The amount of variation explained is 95 percent.

Summary No. 109a
Other Foods—Manpower

Methods used.—Man-hours was related to consumer income and a time trend. An exponential relationship was fitted to the data for the years 1927–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours[1] per week (millions)	Consumer income[2] (billions of 1936 dollars)
1927	5.19	58.9
1928	5.63	62.2
1929	6.32	65.3
1930	6.10	60.4
1931	5.31	54.6
1932	4.90	46.7
1933	5.68	48.2
1934	6.48	54.0
1935	6.82	56.9
1936	7.38	63.9

[1] Computed by multiplying employment by average hours per week. Employment obtained by subtracting sum of wage earners in all individual food-manufacturing segments from the total for the entire food-manufacturing group. All wage earner data are from *Census of Manufactures* in odd years, interpolated by appropriate Bureau of Labor Statistics employment indexes in even years. Average hours per week data are derived from Census data for prevailing hours in 1923 and 1929; for 1932–36 they are an unweighted average of the Bureau of Labor Statistics data for the various food industries; for other years the data were obtained by straight line interpolation.

[2] See table I of this Appendix.

The formula.—The following formula was obtained from the data for the years 1927–32:

$$\text{Calculated man-hours per week} =$$

$$60{,}270\ (1.0395)^{\text{year}-1930}\ \underset{(\text{Billions 1936 dollars})}{(\text{consumer income})}^{1.12047}$$

The average residual for the years covered by the analysis, 1927–32, is 1.7 percent, with a maximum of −3.4 percent in 1931.

The average residual for the extrapolated period, 1933–36, is 5.9 percent, with a maximum of 9.2 percent in 1933.

The amount of variation explained is 94.5 percent.

Summary No. 110a
Confectionery and Chocolate—Manpower

Method used.—Man-hours in the confectionery and chocolate manufacturing industry was related to production and a time trend for the years of the period 1925–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours[1] per week (millions)	Production [2] (1929=100)
1925	3.58	89.3
1926	3.70	99.4
1927	3.52	96.0
1928	3.44	94.0
1929	3.53	100.0
1930	3.01	97.5
1931	2.52	83.7
1932	2.11	77.7
1933	2.14	82.2
1934	2.15	91.1
1935	2.21	96.9

[1] Computed by multiplying average hours per week by employment. Data for hours per week from National Research Project of the Works Progress Administration study, *Productivity in the Confectionery Industry*. Employment data for chocolate and confectionery from the Census for odd years and interpolated by the Bureau of Labor Statistics employment indexes for the noncensus years.

[2] See footnote 1, confectionery and chocolate consumption summary, no. 110b.

The formula.—The following formula was derived from the data for the years 1925–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours per week}}=$$

$$\left\{0.0385\ \underset{(1929=100)}{\text{(production)}}-0.340\right\}\left\{-0.0547\ (\text{year}\ -1927)+1.078\right\}$$

The average residual in the years covered, 1925–32, is 3.0 percent, with the maximum of −5.7 percent occurring in 1926.

The average residual in the years extrapolated (1933–35) is 1.7 percent, with the maximum of 2.3 percent occurring in 1935.

The amount of variation explained is 94 percent.

Summary No. 110b
Confectionery and Chocolate—Consumption

Method used.—This segment includes chocolate and cocoa as well as confectionery proper, but it excludes chewing gum. Consumption was related to real price, consumer income of wage earners, and time. An exponential relationship was fitted to the data for 1922–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (1929=100)	Real price [2] (1929=100)	Consumer income of wage earners [3] (billions of 1936 dollars)
1922	87.2	89.8	10.9
1923	91.5	98.5	13.6
1924	85.3	96.4	12.7
1925	89.3	103.2	12.7
1926	99.4	99.1	13.3
1927	96.0	102.1	13.0
1928	94.0	103.0	13.2
1929	100.0	100.0	13.9
1930	97.5	97.7	11.7
1931	83.7	97.0	9.4
1932	77.7	86.0	6.9
1933	82.2	87.0	7.5
1934	91.1	85.9	9.2
1935	96.9	86.3	10.0

The formula.—The following formula was derived from the data for the period 1922–32:

$$\underset{(1929=100)}{\text{Calculated consumption}}=433.3(1.016)^{\text{year}-1927}\times$$

$$\underset{(1929=100)}{\text{(real price)}}^{-0.6606}\ \underset{\text{(Billions of 1936 dollars)}}{\text{(consumer income of wage-earners)}}^{0.5935}$$

The average residual in the years covered, 1921–32 is 2.4 percent, with a maximum of −6.7 percent in 1924.

The average residual in the years extrapolated, 1933–35, is 3.1 percent, with a maximum of −4.6 percent in 1934 and 1935.

The amount of variation explained is 84 percent.

Summary No. 111a
Boots and Shoes—Manpower

Method used.—The factors which were related to manpower in the boots and shoes industry are the deflated value of output and a time trend for the years 1920–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Deflated value of production [2] (millions 1926 dollars)
1920	97.0	846.6
1921	93.2	761.7
1922	99.0	882.7
1923	113.1	989.9
1924	99.8	898.5
1925	104.2	906.2
1926	99.8	886.7
1927	101.2	907.8
1928	96.1	878.3
1929	100.0	902.0
1930	85.3	733.8
1931	88.8	694.9
1932	81.3	693.8
1933	83.2	611.0
1934	83.0	607.9
1935	82.5	654.2
1936	82.9	736.0

[1] Preliminary report on *Productivity in the Boots and Shoes Industry* (National Research Project of Works Progress Administration). Based upon Census and Bureau of Labor Statistics data.

[2] Derived by deflating value of output by the Bureau of Labor Statistics wholesale price index of boots and shoes. For the method used in deriving the value of output see footnote 1 of summary No. 111b.

The formula.—The following formula was derived by analysis of the data for the years of the period 1920–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}}=$$

$$2.098(0.99805)^{\text{year}-1926}\ \underset{\text{(Millions 1926 dollars)}}{\text{(deflated value of production)}}^{0.5695}$$

The average residual for the years of the period covered, 1920–32, is 2.1 percent, with the maximum of 5.3 percent occurring in 1923.

The average residual for the years of the extrapolated period, 1933–36, is 3.8 percent, with the maximum of −6.1 percent occurring in 1936.

The amount of variation explained is 90 percent.

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[1] For census years the value of products of the confectionery industry and the chocolate and cocoa products industry were totaled and converted into an index on a 1929 base. This value index was deflated by a price index with a 1929 base. From 1925 through 1935 the price series used was from data in *Confectionery Distribution in the United States* published by the Bureau of Foreign and Domestic Commerce. The price index was composed of 10 varieties of confectionery weighted according to 1929 values. The index number for 1923 was derived from census data. The intercensal years of the deflated index were interpolated using the geometric mean between the ratios of the series being interpolated and the interpolation series for preceding and succeeding years. The interpolation series was the index of confectionery output given in the preliminary unpublished report of the National Research Project of the Works Progress Administration, *Productivity in the Confectionery Industry*, for the years 1925–35. The figures for 1923–24 were census output deflated by the Bureau of Labor Statistics index of food prices in 1923 and the same series interpolated by import value for 1922–24. The series on cocoa imports is from the *U. S. Statistical Abstract* and the interpolation is done as described above.

[2] Price index deflated by the Bureau of Labor Statistics cost of living index and converted to a 1929 base. The price index for the years 1925–35 is that of the Bureau of Foreign and Domestic Commerce described above. The index for 1923 is derived from census data and the figures for 1922 and 1924 were interpolated between census-derived figures using the Bureau of Foreign and Domestic Commerce series.

[3] Wages in mining, manufacturing, transportation, and construction. From 1929–36 estimates by Department of Commerce, National Income in 1936, *Survey of Current Business*, June 1936; from 1919 calculated from the National Bureau of Economic Research recent revision of their income series. This was spliced to the 1929 figure of the Department of Commerce. The value data were deflated by the Bureau of Labor Statistics cost of living index.

Summary No. 111b
Boots and Shoes—Consumption

Method used.—The factors related to the consumption of boots and shoes were consumer income and the price of boots and shoes deflated by the cost of living index. There is no reliable measure of consumption of boots and shoes and a value of output deflated by the price of boots and shoes was used adjusted by exports and imports. A better correlation was obtained when this index was lagged a few months. At the end of 1929 there were about four months' supply of boots and shoes on hand in the retail stores. To make a crude adjustment for stocks both the deflated output and the real price of boots and shoes were lagged four months. The results were much more satisfactory than those obtained when the calendar year values were used.

The data.—The following table gives the data used in the analysis for the period 1919–32:

Consumption and related factors

Year	Consumption: Deflated value 4 months lag [1] (millions 1926 dollars)	Consumer income [2] (billions 1936 dollars)	Real price [3] (4 months lag)
1919	817	46.6	116.1
1920	826	47.0	136.8
1921	725	42.3	115.6
1922	829	48.8	102.5
1923	930	54.8	99.1
1924	922	55.4	98.7
1925	902	57.0	97.5
1926	876	58.3	97.0
1927	905	58.9	98.2
1928	874	62.2	108.4
1929	930	65.3	107.5
1930	769	60.4	106.3
1931	717	54.6	107.5
1932	619	46.7	109.9
1933	633	48.2	111.9
1934	609	54.0	124.8
1935	636	56.9	120.7
1936	701	63.9	121.3

The formula.—The formula obtained by using the data for the years of the period 1919–32 is as follows:

$$\underset{\text{(Millions 1936 dollars)}}{\text{Calculated consumption}} = 51.02 \times$$

$$(0.974)^{\text{year}-1926}\ \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})}^{0.9353} \times (\text{deflated price})^{-0.2045}$$

The average residual for the period 1919–32 is 2.2 percent, with the maximum of −6.1 percent occurring in 1930.

The average residual for the extrapolated period, 1933–36, is 3.8 percent, with the maximum of −5.0 percent occurring in 1934.

The amount of variation explained is 94 percent.

Summary No. 112a
Leather Products Other Than Leather and Boots and Shoes—Manpower

Method used.—This segment includes the entire leather group except leather boots and shoes and leather tanned, curried, and finished. The factors which were related to man-hours are production and a time trend. The data for 1919 were not used since the graphical analysis indicated that these were considerably out of line.

The data.—The following table gives the data used in the analysis:

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[1] The general source is the *Census of Manufactures*. The boot and shoe industry of the Census does not coincide with the definition of the segment and it changes its internal classifications from year to year. To overcome these discrepancies an attempt was made to express the total number of pairs of footwear in terms of "boot and shoes proper." For this purpose all "other footwear," slippers, ballet slippers, mocassins, and other footwear were combined and their value multiplied by 0.32, the ratio of average value per pair of all "other footwear" to "boots and shoes proper" as reported by the *Census of Manufactures* from 1919 to 1935. Number of pairs of slippers in 1935 and "other footwear" in 1929 31–32 was not reported. It was therefore assumed that slippers for which no average value per pair was given had the same value per pair as the slippers for which data were given; and that the value per pair of "other footwear" not stated had the same value per pair as the corresponding classification in years where data were given. This computation resulted in a series expressing the number of pairs in "equated units" i. e., the "equivalent" number of pairs of "boots and shoes proper."

This series was filled in for 7 years (intercensus years) by interpolating the series for "boots and shoes proper," and "other footwear," individually using a monthly series published by the Bureau of the Census (in the *Survey of Current Business*). These figures started in 1921, at which time they were supposed to be about 95 percent complete. The coverage estimated annually by the Bureau of the Census was used to raise the figures to an estimated 100 percent, before the interpolation was made. The method was as follows: The ratio of the raised annual series reported by the Bureau of the Census to the series of the *Census of Manufactures* was computed for census years and estimated for intercensus years. The 2 interpolated series were added yielding an annual series of production of "equated number of pairs of boots and shoes."

The value of boots and shoes for census years are obtained from the *Census of Manufactures*. The total value required includes only leather and canvas boots and shoes (excluding canvas rubber-soled shoes), slippers, ballet slippers, and "other footwear," and exclude leggings, gaiters, puttees, "other products," and receipts for contract work. Because of these exclusions the total value of the segment is about 2 percent lower than the total value of the industry reported by the Census; the exact figures were 2.3 percent of the total in 1919 and 1.4 percent in 1927. The percentages for the intervening census years were estimated at 2.1, 1.9, and 1.6 percent, respectively. This discrepancy was small enough to permit linear interpolation and thus calculate the value corresponding to the segment for the census years. These values were divided through by the series on "equated pairs" for corresponding years. For the noncensus years the interpolation was made with the use of 3 annual series which approximate the value per pair.

The first series used was the annual export value per pair of leather footwear including men's and boys', women's, and children's boots and shoes; athletic shoes, sandals, overgaiters, puttees and other leather footwear comparable to the *Census of Manufactures* definition rather than the segment definition of the industry. This series is reported in *Foreign Commerce and Navigation of the United States* of the Bureau of Foreign and Domestic Commerce. Some small error is introduced by the imperfect correspondence of definitions.

The second series used to interpolate the value per pair of boots and shoes was the Bureau of Labor Statistics index of all commodity wholesale prices. The wholesale price of boots and shoes was not used to avoid any spurious correlation which the use of this series might introduce.

The third series was the gross income of leather companies in the United States as given by the *Statistics of Income* for various years (Bureau of Internal Revenue). This series was put on a per "equated pair basis."

In each case the interpolation method used was the same. A least squares straight line was fitted to the scatter of census value per pair and the corresponding values of the interpolating series. The ratio of the actual values to the function values (computed from the regression equation) were computed and plotted against time. A smooth curve was drawn free-hand through these ratios and the values for intercensus years read off. These new ratios were applied to the regression values for the noncensus years and an estimate of value per pair derived for these years.

Each of the 3 interpolation series yielded fairly close estimates for the intercensus years. The final estimates were obtained by averaging the 3 sets of estimates using arbitrarily the following weights: Export value per pair, 3; gross income per pair, 1; and Bureau of Labor Statistics price index, 2.

An annual series of value per pair was thus obtained and this was multiplied by the annual series on equated pairs, giving an annual series for total value for the segment.

The total value of the boot and shoe segment was brought nearer the consumption figure by subtracting the value of exports and adding the value of imports as given in *Foreign Commerce and Navigation of the United States*. The coverage of the Foreign Trade series was approximately the same as that of the *Census of Manufactures* rather than that of the segment, but the error introduced is probably something less than 1 percent of the segment total. A further step to get closer to consumption was to lag the resulting series of value of boots, shoes, and other footwear by 4 months using a simple graphical process—the annual series was cumulated and plotted and the new values read off the ogive curve at the proper intervals. A 4 months lag was used because on the average the shoe trade carries about a 4 months supply of stocks. (See the 1929 *Census of Distribution*.)

This lagged series for total value was reduced to 1936 dollars by dividing it by the Bureau of Labor Statistics index of the price of boots and shoes at wholesale, lagged 4 months, by an arithmetic computation. The resulting series was used to represent consumption of boots and shoes. The question might be raised as to why the series of equated pairs (adjusted for net exports) was not used to represent consumption. Boots and shoes have varied considerably in quality over the period of years and a deflated value corrects in part for quality variations. From the point of view of consumers' purchases, series which allow for variations in quality are more important.

[2] See table I of this Appendix.

[3] The Bureau of Labor Statistics index of the price of boots and shoes (1926=100), lagged 4 months arithmetically and divided by the Bureau of Labor Statistics index of cost of living (1929=100) for the calendar year. The wholesale price was lagged to account in part for the discrepancy between the price at the factory and the price the ultimate consumer pays for the boots and shoes.

Man-hours and production

Year	Man-hours [1] (thousands)	Production [2] (millions of 1926 dollars)
1920	2,800	359
1921	2,180	248
1922	2,680	320
1923	2,940	377
1924	2,520	320
1925	2,650	375
1926	2,710	405
1927	2,860	420
1928	2,900	417
1929	3,040	443
1930	2,500	337
1931	1,990	274
1932	1,580	214
1933	1,710	262
1934	1,850	294
1935	2,150	337

[1] Man-hours obtained by multiplying employment by average hours per week. Employment data from *Census of Manufactures* in odd years, interpolated by Bureau of Labor Statistics index of employment in even years; represents (total leather group) minus (boots and shoes) minus (leather, tanned, curried, and finished) minus ("whips," before 1931). Hours data from National Industrial Conference Board; average hours per week for 25 manufacturing industries. Since the "other leather" group consists of many types of products, it was assumed that the average hours per week would not differ much from those in the "25 manufacturing industries."

[2] Derived from *Census of Manufactures* data: (total leather group) minus (boots and shoes other than rubber) minus (leather, tanned, curried, and finished) minus (whips, before 1931). This value series is deflated by a price index constructed from a Bureau of Labor Statistics price series. The intercensal years were interpolated graphically: 1922-30 by use of an index of consumption of leather of the types used for "other leather products" constructed from data in the *Statistical Abstract* (primary source: Bureau of the Census, *Monthly Census of Hides, Skins, and Leather*); 1920, 1932, 1934, and 1936 by use of consumer income.

The formula.—The following formula was derived from the data for the years of the period 1920–32:

$$\underset{\text{(Thousands)}}{\text{Calculated man-hours per week}} = 31.94\,(0.9851)^{\text{year}-1926}\,\underset{\text{(Millions of 1926 dollars)}}{(\text{production})^{0.7501}}$$

The average residual for the years of the period 1920–32 is 3.0 percent, with the maximum of −5.9 percent occurring in 1926.

The average residual for the years of the extrapolated period, 1933–35 is 6.3 percent, with the maximum of −8.6 percent occurring in 1933.

The amount of variation explained is 95 percent.

Summary No. 112b
Leather Products Other Than Leather and Boots and Shoes—Consumption

Method used.—The factors related to consumption were consumer income, real price, and a time trend. Real price was obtained by deflating the price of leather products (excluding leather and boots and shoes) by the Bureau of Labor Statistics wholesale price of all commodities.

The data.—The following table gives the data used in the analysis for the years of the period 1920–32:

Consumption and related factors

Year	Consumption [1] (millions 1926 dollars)	Consumer income [2] (billions 1936 dollars)	Real price [3] (1926=100)
1920	354	47.0	92
1921	257	42.3	122
1922	325	48.8	118
1923	382	54.8	103
1924	324	55.4	106
1925	380	57.0	100
1926	413	58.3	100
1927	430	58.9	107
1928	426	62.2	109
1929	459	65.3	109
1930	352	60.4	118
1931	287	54.6	132
1932	226	46.7	133
1933	268	48.2	119
1934	290	54.0	110
1935	341	56.9	101
			108

The formula.—The formula obtained by using the data for the period of the years 1920-32 is as follows:

$$\underset{\text{(Millions of 1926 dollars)}}{\text{Calculated consumption}} = 10.24 \times (0.9816)^{\text{year}-1926}\,\underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})^{1.4666}}\;\underset{(1926=100)}{(\text{deflated price})^{-0.4957}}$$

The average residual for the period, 1920–32 is 4.4 percent, with the maximum of −15.0 percent occurring in 1924.

The average residual for the extrapolated period, 1933–35, is 4.8 percent, with the maximum of 8.5 percent occurring in 1933.

The amount of variation explained is 90 percent.

Summary No. 113a
Woolen and Worsted Goods—Manpower

Method used.—Man-hours is related to production and a time trend from 1919–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1919	107.7	92.9
1920	90.0	86.2
1921	98.2	91.7
1922	107.0	108.2
1923	135.5	119.2
1924	110.8	97.7
1925	106.7	105.5
1926	99.1	97.6
1927	102.1	98.7
1928	96.3	93.2
1929	100.0	100.0
1930	72.0	79.5
1931	73.2	82.6
1932	60.1	73.5
1933	76.9	86.8
1934	57.1	76.0
1935	83.0	93.0

[1] Man-hours is the product of an index of weekly hours and an index of employment. For employment the Bureau of Labor Statistics index is used for 1923-36, with the years 1919 and 1921 spliced on by means of Census wage earners at 1923, and the years 1920 and 1922 interpolated with National Industrial Conference Board data. Average hours are Bureau of Labor Statistics data for 1933-36, National Industrial Conference Board data for 1920-31, an average of these two for 1932, and an extrapolation based on Census prevailing hours for 1919. Data for 1920 and 1922, for which years National Industrial Conference Board data cover only 7 and 6 months, respectively, were corrected by assuming a straight line relationship for man-hours for the remaining months.

[2] Based on Day-Thomas index of production (V. S. Kolesnikoff, Index of Production of Manufactures Derived from Census Data, 1933, *Journal of American Statistical Association*, vol. 30, No. 191, September 1935, supplement, p. 582). Intercensal years interpolated, and 1935 extrapolated by means of the Federal Reserve Board index of textile production.

The formula.—The following formula was derived by correlation analysis for the years of the period 1919–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 0.2624\,(0.9861)^{\text{year}-1926}\,\underset{(1929=100)}{(\text{production})^{1.2959}}$$

The average residual for the years of the period 1919–32 is 3.6 percent, with the maximum of −10.8 percent occurring in 1922.

The average residual for the years of the extrapolated period 1933–35 is 4.3 percent, with the maximum of −11.2 percent occurring in 1934.

The amount of variation explained is 93 percent.

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[1] Based on production adjusted for exports and imports. Production is derived from the *Census of Manufactures* by deflating the value by the price of leather products. Price was constructed from the Bureau of Labor Statistics price series for leather products, excluding leather and boots and shoes. For the intercensus years between 1921 and 1931 production was obtained by interpolation using the consumption of leather of types used for other leather products as an interpolating series. For the noncensus years before 1921 and after 1931 man-hours was used as an interpolating series.

[2] See table I of this Appendix.

[3] Derived from Bureau of Labor Statistics price indexes for belting, women's gloves, men's gloves, harnesses, suitcases, and traveling bags; each index weighted by the Bureau of Labor Statistics weight, and the composite index divided by the Bureau of Labor Statistics index of wholesale price of all commodities.

Summary No. 113b
Woolen and Worsted Goods—Consumption

Method used.—The factors related to consumption of woolen and worsted goods are consumer income of the current year and of the previous year and a time trend. The graphical anaylsis indicated that the residuals obtained were related to a two-year cycle and so a third factor was introduced representing a two-year cycle. The extrapolated values were unsatisfactory principally because the consumption figure used does not take into account changes in stocks.

The data.—The following table gives the data used in the analysis for the period 1921–32:

Consumption and related factors

Year	Consumption (1929=100)[1]	Consumer income[2] (percent of current year to previous year)	2-year cycle[3]
1921	90.7	90.0	1
1922	107.9	115.4	0
1923	119.1	112.3	1
1924	97.8	101.1	0
1925	105.7	102.9	1
1926	97.9	102.3	0
1927	98.9	101.0	1
1928	93.3	105.6	0
1929	100.0	105.0	1
1930	78.6	92.5	0
1931	80.6	90.4	1
1932	72.6	85.5	0
1933	84.7	103.2	1
1934	74.3	112.0	0
1935	91.0	105.4	1

[1] Consumption: Day-Thomas index of production of woolen and worsted goods for census years, interpolated and extrapolated with the Federal Reserve Board index of textile production, adjusted for imports and exports.

[2] Consumer income of present year as a percent of income of previous year. See table I of this Appendix.

[3] Cycle: A 2-year cycle represented by an arbitrary variate having the value of 1 in odd years and 0 in even years.

The formula.—The formula obtained by using the data for the period of the years 1921–32 is as follows:

$$\underset{(1929=100)}{\text{Calculated consumption}} =$$

$$0.4800 \left(\begin{matrix}\text{consumer income percent of}\\ \text{current year to previous year}\end{matrix}\right)^{1.1404} \times$$

$$(0.9880)^{\text{year}-1926}\,(1.076)^{\text{cycle factor}}$$

The average residual for the years of the period 1921–32 is 2.3 percent, with the maximum of −4.7 percent occurring in 1922.

The average residual for the years of the extrapolated period 1933–35 is 11.5 percent, with the maximum of −21.5 percent occurring in 1934.

The amount of variation explained is 95 percent.

Summary No. 114a
Cotton Textiles—Manpower

Method used.—The factors which were related to man-hours are an index of production and a time trend. The formula presented below is linear; this type has been used instead of the usual multiplicative form because the resulting fit would be essentially the same and the linear form is much more easily derived by use of the least squares criterion.

The data.—The following table gives the data used in the analysis for the years of the period 1920–35:

Manpower and related factors

Year	Man-hours[1] (1929=100)	Production[2] (1929=100)
1920	101.0	84.3
1921	95.8	78.3
1922	99.6	90.8
1923	114.7	99.6
1924	92.1	84.5
1925	107.0	97.3
1926	104.4	99.3
1927	110.3	104.9
1928	91.0	94.0
1929	100.0	100.0
1930	78.5	74.3
1931	76.5	73.4
1932	67.4	67.8
1933	81.8	85.1
1934	67.3	71.8
1935	65.8	72.8

[1] Preliminary report on *Productivity in the Cotton Goods Industry* (National Research Project of the Works Progress Administration). Based upon Bureau of Labor Statistics index of employment and hours per week data from Bureau of Labor Statistics and National Industrial Conference Board.

[2] Op. cit., based upon census statistics on output of 30 products weighted by unit value in 1929 in odd years and interpolated by means of Federal Reserve Board index of cotton consumption in even years; interpolation based on linear ratios for intercensal years.

The formula.—The formula obtained by using the data for the years of the period 1920–32 is as follows:

$$\underset{(1929=100)}{\text{Calculated man-hours}} =$$

$$16.3 + 0.896\ \underset{(1929=100)}{(\text{cotton textile production})} - 1.714\ (\text{year} - 1926)$$

The average residual for the years of the period covered, 1920–32 is 2.7 percent, with the maximum of −6.7 percent occurring in 1928.

The average residual for the years of the extrapolated period, 1933–35, is 1.0 percent, with the maximum of 2.1 percent occurring in 1933.

The amount of variation explained is 94 percent.

Summary No. 114b
Cotton Textiles—Consumption

Method used.—No satisfactory consumption index of cotton textiles is available. No data are available on stocks. A crude measure has been used by representing the consumption of cotton textiles with mill consumption of raw cotton. The factors related to mill consumption of raw cotton are: (1) Federal Reserve Board index of industrial production, (2) the price of raw cotton deflated by general wholesale prices, (3) the rate of change of cotton goods prices—represented by the ratio of the November price of cotton goods of the current year to November price of cotton goods of the previous year.

The results of the analysis are unsatisfactory because the index used to represent consumption was very crude. The rate of change in the price of cotton goods was used in order to be able to take into account, in part, the speculative activity in raw cotton and consequently the stocking up or depletion of cotton goods by producers.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Mill consumption of raw cotton (1923–25=100) [1]	Index of manufacturing production (1923–25=100) [1]	Deflated price of raw cotton (1920=100) [2]	Rate of change of cotton goods price (percentage) [3]
1919	96	84	132.7	113.6
1920	95	87	125.2	75.8
1921	88	67	88.1	80.9
1922	99	86	125.1	104.2
1923	106	101	167.0	107.5
1924	90	94	166.7	93.3
1925	104	105	129.3	96.8
1926	109	108	100.0	86.2
1927	120	106	104.7	111.3
1928	107	112	117.7	96.4
1929	114	119	114.5	96.9
1930	87	95	89.7	79.6
1931	88	80	66.9	75.0
1932	81	63	56.7	92.3
1933	101	75	74.7	160.4
1934	88	78	94.2	98.1
1935	91	90	84.8	101.7
1936	115	105	85.6	99.6

[1] Federal Reserve Board.

[2] Price of raw cotton N. Y. Upland Middling, given in the *Survey of Current Business*, 1936 supplement, deflated by Bureau of Labor Statistics index of wholesale prices of all commodities.

[3] The ratio of Bureau of Labor Statistics November prices of cotton goods of current year to November prices of previous year.

The formula.—The following formula was derived using the data for 1919–32:

$$\underset{(1923\text{-}25=100)}{\text{Calculated consumption}} = 3.002\,(0.9897)^{\text{year}-1926}\,\underset{(1923\text{-}25=100)}{(\text{industrial production})}^{0.6924}\times$$

$$(\text{rate of change in cotton goods prices}^{0.3124})\times$$

$$\underset{(1926=100)}{(\text{deflated price of raw cotton})}^{-0.2257}$$

The average residual for the years of the period 1919–32 is 2.8 percent, with the maximum of −9.4 percent in 1930; the average residual for the period 1933–36 is 4.8 percent, with a maximum of 9.5 percent in 1936.

The amount of variation explained is 83 percent.

Summary No. 115a
Silk and Rayon—Manpower

Method used.—Manpower, measured in terms of man-hours, was related to an index of production and time for the period 1919–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (millions)	Production [2] (1929=100)
1919	5.76	57.6
1920	5.44	40.9
1921	5.45	53.3
1922	5.44	63.6
1923	5.82	67.3
1924	5.41	63.9
1925	6.21	77.0
1926	5.85	76.4
1927	5.86	82.5
1928	6.01	89.1
1929	6.24	100.0
1930	5.37	83.1
1931	4.84	91.5
1932	3.62	91.1
1933	4.14	87.6
1934	3.74	96.7
1935	4.04	108.1

[1] Computed by multiplying employment by average hours per week. Employment data are from Census in odd years, interpolated by Bureau of Labor Statistics index of employment in even years; average hours per week from National Industrial Conference Board.

[2] Based upon Day-Thomas index of production (V. S. Kalesnikof, Index of Production of Manufacturers Derived From Census Data, 1933. *Journal of American Statistical Association*, vol. 30, No. 191, September 1935, supplement, p. 582). 1935 figure is deflated value of product, *Census of Manufacturers*, spliced onto the Day-Thomas index at 1933. The even years are interpolated from free-hand regression lines using an index of silk production from the Rayon Organon 1936 (Textile Economics Bureau, Inc., New York) representing deliveries to mills minus exports. Entire series adjusted to a 1929 base.

The formula.—The following formula was derived from the data for the years 1919–32:

$$\underset{(\text{Millions})}{\text{Calculated man-hours}} =$$

$$0.3216\,\underset{(1929=100)}{(\text{production})}^{0.657003}\,[1.032-0.0516\,(^{\text{year}-1926})]$$

The average residual for the years of the period covered, 1919–32, is 6.6 percent, with the maximum of −19.7 percent occurring in 1932.

The average residual for the years of the extrapolated period, 1933–35, is 3.6 percent, with the maximum of −6.7 percent occurring in 1934.

The amount of variation explained is 53 percent.

Summary No. 115b
Silk and Rayon—
Consumption

Method used.—Consumption of silk and rayon was related to a geometric average of the current and previous years' consumer income, the consumption of the previous year, and a time trend. The correlation analysis covered the years 1924–32, as it was felt that the Census data used did not adequately reflect the influence of rayon prior to 1924. An exponential form was used for the first least squares solution, after which the partial regression with respect to time was fitted with a straight line instead of the usual exponential curve.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (1929=100)	Consumer income, 2 year average [2] (Billions 1936 dollars)	Consumption previous year [1] (1929=100)
1924	64.2	55.1	67.8
1925	76.1	56.2	64.2
1926	77.0	57.7	76.1
1927	83.3	58.6	77.0
1928	89.8	60.5	83.3
1929	100.0	63.8	89.8
1930	91.0	62.8	100.0
1931	89.5	57.4	91.0
1932	69.6	50.5	89.5
1933	85.0	47.4	69.6
1934	85.4	51.0	85.0
1935	103.7	55.4	85.4

[1] Consumption: The Day-Thomas index of production of silk and rayon as extended by Joy & Kolesnikof was used for census years 1919 to 1933. For 1935 census value of products deflated by the Bureau of Labor Statistics index of silk and rayon wholesale prices was spliced at 1933. This series was then interpolated by the man-hours series by the geometric mean of ratios of previous and subsequent years. An adjustment was then made for imports and exports to obtain the amount of silk and rayon available for consumption.

[2] See table I of this Appendix; geometric average of current and previous year of consumer income.

The formula.—The following formula was obtained from the data for the period 1924–32:

$$\underset{(1929=100)}{\text{Calculated consumption}} = [0.2704 + 0.02265\,(^{\text{year}-1926})]\times$$

$$\left(\begin{array}{c}\text{consumer income 2-year}\\ \text{average}\\ \text{(Billions 1936 dollars)}\end{array}\right)^{2.4848}\quad(\text{consumption previous year})^{-1.0266}$$

The exponents being determined by the first least squares solution (including a time exponential); the time factor being determined from the resulting partial regression on time.

The average residual for the years covered by the analysis, 1924–32, is 1.6 percent, with the maximum of 2.9 percent occurring in 1930.

The average residual for the years extrapolated, 1933–35, is 3.7 percent, with the maximum of 5.9 percent occurring in 1933.

The amount of variation explained is 97.5 percent.

Summary No. 116a
Rayon—Manpower

Method used.—Manpower in the rayon yarn industry was related to the output and a time trend. An exponential function was fitted to the data for 1923–32. The time trend was later modified by substituting a free-hand curve for the exponential form.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (thousands)	Production [2] (millions of equated pounds of rayon)
1923	683	34.50
1924	730	36.33
1925	934	51.94
1926	1,142	63.05
1927	1,288	78.38
1928	1,506	103.90
1929	1,915	129.10
1930	1,854	138.73
1931	1,808	167.70
1932	1,576	154.30
1933	1,854	236.37
1934	1,725	235.52
1935	1,915	289.91
1936	2,016	315.90

[1] Computed by multiplying employment by average hours per week. Employment from census in odd years, interpolated by Bureau of Labor Statistics employment index in even years. Average hours per week are Bureau of Labor Statistics data for 1932–36, census prevailing hours in 1929, straight-line interpolation in 1930 and 1931, and assumed to be same as in 1929 in all prior years.

[2] Derived from data in *Rayon Organon* (Textile Economics Bureau, Inc., New York). Represents output of rayon in pounds plus the output of cellophane expressed in units equivalent to pounds of rayon.

The formula.—The following formula was derived from the data for 1923–33:

$$\underset{\text{(Thousands)}}{\text{Calculated man-hours per week}} =$$

$$[-0.4710+5.219\,(0.8979)^{\text{year}-1930}]\,\underset{\text{(Million pounds)}}{(\text{production})^{1.2063}}$$

The average residual for the years covered by the analysis, 1923–32, was 4.5 percent, with a maximum of −7.6 percent occurring in 1928.

The average residual in the extrapolated years, 1933–36, was 7.6 percent with a maximum of −15.0 percent occurring in 1933.

The amount of variation explained is 96 percent.

Summary No. 116b
Rayon—Consumption

Method used.—The consumption of rayon was related to a time trend and a 2-year cyclical factor. An exponential relationship was fitted to the data for the years 1925–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Rayon consumption [1] (million pounds)	2-year cycle
1925	58.3	10
1926	60.6	1
1927	100.0	10
1928	100.1	1
1929	131.4	10
1930	118.0	1
1931	157.4	10
1932	152.0	1
1933	211.9	10
1934	199.8	1
1935	252.7	10
1936	297.6	1

[1] *Rayon Organon* (Textile Economics Bureau, Inc., New York), February 1936.

The formula.—The following formula was derived from the data for the years 1925–32:

$$\underset{\text{(Million pounds)}}{\text{Rayon consumption}} =$$

$$102.8\,(1.167)^{\text{year}-1929}\,[1.0995+0.0995\,(-1)^{\text{year}-1929}]$$

The average residual for the period 1925 to 1932 is 7.9 percent, with a maximum of 14.4 percent occurring in 1928.

The average residual for the period 1933–35 is 8.9 percent, with a maximum of −18.2 percent occurring in 1935.

The amount of variation explained is 93 percent.

Summary No. 118a
Knit Goods—Manpower

Method used.—The factors which were related to man-hours are production of knit goods and a time trend, using the data for the years 1919–32. An exponential relation was fitted, the time factor being subsequently modified.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1919	81.1	52.9
1920	81.5	58.5
1921	76.3	59.8
1922	91.2	73.0
1923	90.7	73.9
1924	77.1	66.9
1925	84.8	78.1
1926	85.3	78.9
1927	90.1	83.7
1928	89.7	86.6
1929	100.0	100.0
1930	83.2	91.6
1931	75.7	91.1
1932	73.0	95.4
1933	76.3	105.7
1934	68.9	98.7
1935	76.4	111.2

[1] Computed by multiplying Bureau of Labor Statistics employment index by National Industrial Conference Board average hours per week and adjusting to 1929 base.

[2] Data for odd years from preliminary report on *Productivity in the Knit Goods Industry* (National Research Project of the Works Progress Administration). Interpolation for even years based on assumption of linear movement of productivity in intercensall years.

The formula.—The following formula was derived from the data for the years of the period 1919–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 0.4192\,(0.9471)^{\text{year}-1924} \times$$

$$\underset{(1929=100)}{(\text{production})^{1.21514}}$$

The scatter about the time trend was such as to indicate that a minor modification was called for. Accordingly, when the trend was modified the resulting formula was:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 1.1297 \times [-0.05425 + 0.2802\,(0.9548)^{\text{year}-1927}] \times \underset{(1929=100)}{(\text{production})}^{1.21514}$$

The average residual for the years of the period covered, 1919–32, is 3.3 percent, with the maximum residual of 6.2 percent occurring in 1928.

The extrapolated values for the years 1933–35 are very close; the average residual for these years is 2.3 percent, with the maximum of −4.4 percent occurring in 1933.

The amount of variation explained is 79 percent.

Summary No. 118b
Knit Goods—Consumption

Method used.—The factors related to the consumption of knit goods were consumer income and a time trend. Price relative to textiles and to cost of living was tried but seemed to contribute little or nothing to the net relationships. The effect of price was probably accounted for by the consumer income and time trend factors. An exponential relationship was fitted to the data for the years 1924–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (1929=100)	Consumer income [2] (billions, 1936 dollars)
1924	64.8	55.4
1925	75.4	57.0
1926	76.6	58.3
1927	81.5	58.9
1928	84.7	62.2
1929	100.0	65.3
1930	91.0	60.4
1931	90.4	54.6
1932	94.9	46.7
1933	105.2	48.2
1934	98.1	54.0
1935	110.7	56.9

[1] Derived by adjusting index of production obtained from the National Research Project (preliminary data) by the value of exports and imports as given in *Statistical Abstracts* (Department of Commerce).

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years of the period 1924 to 1932:

$$\underset{(1929=100)}{\text{Calculated consumption}} = 10.431\ (1.051)^{\text{year}-1928} \times \underset{(\text{Billions of 1936 dollars})}{(\text{consumer income})}^{0.5141}$$

The average residual for the years 1924 to 1932 is 3.5 percent, with the maximum 6.4 percent occurring in 1929.

The consumption of knit goods for each of the years 1933, 1934, and 1935 was calculated from the formula. The average residual for the 3 years was 7.8 percent, with a maximum of −9.9 percent occurring in 1934.

The amount of variation explained is 88 percent.

Summary No. 119a
Wearing Apparel—Manpower

Method used.—Man-hours was related to the deflated value of output and a time trend. An exponential relationship was fitted to the data for the years 1919–32 (1920, 1922, and 1924 were omitted because of lack of data).

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Deflated value of output [2] (billions of 1926 dollars)
1919	23.51	2.516
1921	21.88	1.811
1923	23.07	3.168
1925	21.38	3.048
1926	21.57	3.200
1927	22.83	3.541
1928	23.25	3.640
1929	24.20	3.939
1930	20.99	3.580
1931	18.51	3.279
1932	15.32	2.700
1933	15.46	2.490
1934	15.52	2.730
1935	18.02	2.955

[1] Computed by multiplying employment by average hours per week. Wage earners from the *Census of Manufactures* for odd years, interpolated by the employment index of the Bureau of Labor Statistics in even years. Average hours per week were obtained from the Bureau of Labor Statistics for 1932–36, from Census prevailing hours for 1921, 1923, and 1929, and by straight-line interpolation for other years.

[2] Value of output was obtained from the *Census of Manufactures* for odd years; 1926, 1928, 1930, and 1932 were interpolated using the gross income of clothing manufacturing corporations as given in *Statistics of Income* (Bureau of Internal Revenue); 1934 was interpolated by the consumer income series. This series was deflated by a price index. For 1926–36 the Bureau of Labor Statistics clothing price index was used; for 1919–25 the clothing price was estimated on the basis of the relation between the clothing index and the Bureau of Labor Statistics textile price index for 1926–36.

The formula.—The following formula was derived from the data for the years 1919–32:

$$\underset{(\text{Millions})}{\text{Calculated man-hours per week}} = 12.367\ (0.9666)^{\text{year}-1920} \times \underset{(\text{Billions 1926 dollars})}{(\text{value of output})}^{0.50014}$$

The average residual for the years covered by the analysis, 1919–32, is 5.2 percent, with the maximum of 11.0 percent occurring in 1921.

The average residual for the extrapolation years, 1933–35, is 5.8 percent; with the maximum of 15.0 percent occurring in 1935.

The amount of variation explained is 77 percent.

Summary No. 119b
Wearing Apparel—Consumption

Method used.—Consumption was related to the average of consumer income for the current and previous year. An exponential relationship was fitted to the data for the years 1924–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (millions of 1926 dollars)	Consumer income average current and previous year [2] (billions of 1936 dollars)
1924	2,780	55.1
1925	3,125	56.2
1926	3,219	57.6
1927	3,561	58.0
1928	3,655	60.6
1929	3,952	63.8
1930	3,588	62.8
1931	3,286	57.5
1932	2,708	50.6
1933	2,499	47.4
1934	2,740	51.1
1935	2,965	55.4

[1] Production index adjusted for imports and exports. See footnote 2, summary No. 119a.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1924–32:

$$\underset{\text{(Millions of 1926 dollars)}}{\text{Calculated consumption}} =$$

$$3.663\ \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income average current and previous year})}^{1.6757}$$

The average residual for the years 1924–32 is 3.3 percent, with a maximum of −8.2 percent occurring in 1924.

The average residual over the extrapolated period, 1933–35, is 4.0 percent, with a maximum of 6.1 percent occurring in 1933.

The amount of variation explained is 87 percent.

Summary No. 120a
Dyeing and Finishing—Manpower

Method used.—The number of wage earners was related to the Federal Reserve Board's index of production and a time trend.

Data used.—The following table presents the data used in the analysis:

Manpower and related factors

Year	Wage earners [1] (thousands)	Industrial production [2] (1923–25=100)
1921	51.5	67
1922	54.9	85
1923	63.4	101
1924	61.1	95
1925	70.7	104
1926	72.1	108
1927	73.8	106
1928	74.8	111
1929	79.3	119
1930	73.0	96
1931	67.6	81
1932	60.5	64
1933	66.3	76
1934	72.9	79
1935	74.7	90

[1] *Census of Manufactures* data in odd years, interpolated by means of Bureau of Labor Statistics index of employment in even years.

[2] See table I of this Appendix.

The formula—The following formula was obtained by analysis of the data for the years of the period 1921–32:

$$\underset{\text{(Thousands)}}{\text{Calculated wage earners}} =$$

$$5.42\ (1.023)^{\text{year}-1926}\ \underset{(1923\text{–}25=100)}{(\text{industrial production})}^{0.550}$$

The average residual for the years of the period covered, 1921–32, is 2.4 percent with the maximum of 4.9 percent occurring in 1921.

The average residual for the years of the extrapolated period, 1933–35, is 3.5 percent, with the maximum of −5.3 percent occurring in 1935.

The amount of variation explained is 95 percent.

Summary No. 120.1a
Other Textiles—Manpower

Method used.—Man-hours was related to the deflated value of output and a time trend. An exponential relation was fitted to the data for 1923–32, and the time trend factor was subsequently modified.

The Data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Deflated value of output [2] (millions of 1926 dollars)
1923	7.71	1,144
1924	6.51	983
1925	7.17	1,114
1926	7.27	1,125
1927	7.79	1,239
1928	7.73	1,221
1929	8.19	1,372
1930	6.49	1,039
1931	5.93	1,029
1932	4.66	844
1933	5.08	914
1934	4.80	890
1935	5.58	1,207
1936	6.24	1,298

[1] Wage earners were obtained from the *Census of Manufacturers* for odd years, even years from 1924–34 were interpolated using an average of Bureau of Labor Statistics employment indexes for dyeing and finishing fur felt hats, and all textiles. Average hours per week were estimated from Census prevailing hours for 1919, 1921 1923, and 1929, and Bureau of Labor Statistics average hours data for 1932 through 1936.

[2] For odd years the value of output from the *Census of Manufactures* was deflated by a price index computed by weighting equally the Bureau of Labor Statistics indexes for "other textiles" and "all textiles." The series so obtained was interpolated for even years using the Federal Reserve Board index of textile activity.

The formula.—The following formula involving a modification of the time trend was derived from the data for the period 1923–32:

$$\underset{\text{(Billions)}}{\text{Calculated man-hours per week}} =$$

$$[8.384-2.211\ (1.059)^{\text{year}-1928}]\ \underset{\text{(Billions of 1926 dollars)}}{(\text{deflated output})}^{1.0471}$$

The average residual for the years covered by the analysis is 1.4 percent with a maximum of 5.5 percent occurring in 1930.

The average residual for the extrapolated years, 1933–36, is 4.6 percent, with a maximum of −9.9 percent occurring in 1935.

The amount of variation explained is 97.5 percent.

Summary No. 120.1b
Other Textiles—Consumption

Method used.—The deflated value of the consumption of other textiles was related to the Federal Reserve Board index of industrial production, the average of the real price for the current and previous years, and a 2-year cycle [4] factor. An exponential relationship was fitted to the data for the years of the period 1922–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption deflated value [1] (millions of 1926 dollars)	Industrial production [2] (1923-5=100)	Real price 2-year average [3] (1929=100)
1922	1,093	85	84.6
1923	1,271	101	91.0
1924	1,103	95	96.3
1925	1,244	104	99.1
1926	1,287	108	98.7
1927	1,392	106	100.8
1928	1,374	111	100.1
1929	1,533	119	97.5
1930	1,166	96	95.7
1931	1,113	81	95.9
1932	904	64	95.8
1933	983	76	99.5
1934	958	79	100.8
1935	1,289	90	92.3

[1] The deflated value of net imports was added to the production series as used in the manpower analysis (see summary No. 120.1a).

[2] Data from table 1 of this Appendix.

[3] 2-year average relative price: The average of the Bureau of Labor Statistics price indexes for all textiles and other textiles equally weighted was deflated by the Bureau of Labor Statistics index of wholesale prices; the average of the current and preceding year was then taken.

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[4] 2-year cycle with the value 10 in even years and 1 in odd years.

The formula.—The following formula was derived from the data for the years 1922–32:

$$\underset{\text{(Billions of 1926 dollars)}}{\text{Calculated consumption}} = (0.1807 + 0.003741\ (-1)^{\text{year}-1927}) \times (1.0113)^{\text{year}-1927} \times \underset{(1929=100)}{(\text{real price—2 year average})}^{-0.4494}\ \underset{(1923\text{-}25=100)}{(\text{industrial production})}^{0.8670}$$

The average residual for the years covered by the analysis, 1922–32, is 2.2 percent, with the maximum of −5.4 percent occurring in 1930.

The average residual for the extrapolated years, 1933–35, is 6.5 percent, with the maximum of −10.2 percent occurring in 1934.

The amount of variation explained is 95 percent.

Summary No. 121a
Paper and Pulp—Manpower

Method used.—Man-hours was related to production and a time trend for the years of the period 1919–32.

The data.—The following table presents the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Production [2] (1929=100)
1919	5.82	58.2
1920	6.68	66.2
1921	5.18	50.8
1922	5.76	65.4
1923	6.25	73.2
1924	5.86	72.1
1925	6.35	82.2
1926	6.64	88.4
1927	6.35	89.5
1928	6.19	93.2
1929	6.67	100.0
1930	6.08	92.1
1931	4.77	85.5
1932	4.07	72.9
1933	4.39	83.7
1934	4.51	84.5
1935	4.91	95.8

[1] Computed by multiplying employment by average hours per week. Employment data are from *Census of Manufactures* in odd years, interpolated by Bureau of Labor Statistics index of employment in even years. Average hours per week data are from National Industrial Conference Board, *Wages, Hours, and Employment in the United States, 1914–36*, pp. 132–135; figure for 1919 extrapolated by linear trend from data for 1920–29.

[2] Derived from production data in *Census of Manufactures* and *Survey of Current Business*. Census data for pulp production interpolated by *Survey of Current Business* data on paper production. The index of production for paper and pulp was constructed by combining the *Survey of Current Business* series for paper production and the above series for wood pulp production with 1929=100, each series being weighted by the average of the unit values for the census years 1921 to 1933 inclusive.

The formula.—The following formula was obtained using the data for the years of the period 1919–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours per week}} = 0.0824\ (0.9545)^{\text{year}-1926}\ \underset{(1929=100)}{(\text{production})}^{0.9773}$$

The average residual for the years of the period covered, 1919–32, is 2.8 percent, with the maximum of 6.9 percent occuring in 1930.

The average residual for the years of the extrapolated period, 1933–35, is 3.8 percent, with the maximum of 4.9 percent occurring in 1935.

The amount of variation explained is 93 percent.

Summary No. 121b
Paper and Pulp—Consumption

Method used.—Consumption of paper and pulp was related to an index of consumer income and production combined, and a time trend. The additive form was fitted in this case because the graphical analysis indicated that a better fit would result than that given by the usual exponential formula.

The data.—The following table presents the data used in the analysis for the years of the period 1919–32:

Consumption and related factors

Year	Paper consumption [1] (ten thousand net tons)	Index of consumer income and production [2] (1923-25=100)
1919	649	84
1920	786	86
1921	605	72
1922	800	86
1923	934	100
1924	924	97
1925	1,059	103
1926	1,181	106
1927	1,192	106
1928	1,245	112
1929	1,335	118
1930	1,225	102
1931	1,123	90
1932	960	74
1933	1,086	81
1934	1,121	88
1935	1,262	96
1936	1,135	110

[1] *Agricultural Statistics*, U. S. Department of Agriculture, 1936, p. 380; 1937, p. 439.

[2] Combined index of consumer income in billions of 1936 dollars (see table I of this Appendix) expressed as an index (1923–25=100), plus the Federal Reserve index of industrial production (see table I of this Appendix).

The formula.—The following formula was obtained using data for the years of the period 1919–32:

$$\underset{\text{(Ten thousand net tons)}}{\text{Calculated paper consumption}} = 573 + 11\ \underset{(1923\text{-}25=100)}{(\text{average industrial production and consumer income})} - 533.33\ (0.9491)^{\text{year}-1928}$$

The average residual for the years of the period covered, 1919–32, is 2.0 percent, with the maximum of −6.2 percent occurring in 1924.

The average residual for the years of the extrapolated period, 1933–36, is 1.5 percent, with the maximum of 3.0 percent occurring in 1933.

The amount of variation explained is 97 percent.

Summary No. 122a
Lumber and Millwork—Manpower

Method used.—The factors which were related to manpower are production of lumber and time. The relation was expressed by an exponential function.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Production [2] hundred (millions of feet, board measure)
1920	25.7	359
1921	21.6	290
1922	28.5	253
1923	29.6	410
1924	28.3	398
1925	28.4	410
1926	27.1	398
1927	24.4	373
1928	23.8	368
1929	23.7	369
1930	16.6	261
1931	10.1	165
1932	7.0	102
1933	8.0	140
1934	9.5	155
1935	11.9	170

[1] Computed from Bureau of Labor Statistics employment figures adjusted to 1935 census and National Industrial Conference Board actual hours per week.

[2] *Lumber Industry Market Research Series 104*, Department of Agriculture (U. S. Forest Service).

The formula.—The following formula was derived by correlation analysis using the data for the years of the period 1920–32:

$$\underset{\text{(Millions per week)}}{\text{Calculated man-hours}} = 0.1028\ (0.9792)^{\text{year}-1926}\ \underset{\text{(Hundred millions of feet board measure)}}{(\text{production})^{0.92965}}$$

The average residual for the years of the period 1920–32 is 2.6 percent, with the maximum of 9.2 percent occurring in 1922.

The average residual for the extrapolated period 1933–35 is 7.8 percent, the maximum of 14.4 percent occurring in 1935.

The amount of variation explained is 98.5 percent.

Summary No. 122b
Lumber and Millwork—Consumption

Method used.—Consumption of lumber was related to the Federal Reserve Board index of industrial production and a time trend for the period 1925–32. The additive farm was used to fit the data because the graphical analysis indicated that a better fit would result than that given by the usual power formula.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (hundred millions board feet)	Industrial production [2] (1923–25=100)
1925	395	104
1926	381	108
1927	354	106
1928	354	111
1929	333	119
1930	233	96
1931	178	81
1932	117	64
1933	145	76
1934	115	79
1935	172	90

[1] Department of Commerce, Bureau of Foreign and Domestic Commerce. *The Lumber Industry* (Market Research Report No. 104).

[2] Data from table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1925–32:

$$\underset{\text{(Hundred millions board feet)}}{\text{Calculated consumption}} = 2.963\ \underset{(1923\text{-}5=100)}{(\text{industrial production})} + 96.1\ (0.8279)^{\text{year}-1930} - 136.2$$

The average residual for the years 1925–32 is 2.8 percent, with the maximum of 8.5 percent occurring in 1928.

The average residual for the extrapolated period, 1933–35, is 3.0 percent with the maximum of 3.5 percent occurring in 1935.

The amount of variation explained is 97 percent.

Summary No. 123a
Paper Products—Manpower

Method used.—Man-hours is related to the deflated value of output and a time trend. An exponential relationship is fitted to the data for the years 1919–20 and 1922–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (thousands)	Output [2] (Millions of 1926 dollars)
1919	4,444	401.7
1920	4,586	464.0
1921	3,210	375.8
1922	4,349	466.2
1923	4,681	534.6
1924	4,606	531.7
1925	4,629	546.5
1926	4,748	634.3
1927	4,791	690.7
1928	4,850	711.3
1929	5,215	779.7
1930	4,716	679.8
1931	4,010	639.9
1932	3,440	566.0
1933	3,608	622.8
1934	3,778	674.2
1935	4,152	805.2
1936	4,643	934.2

[1] Computed by multiplying employment by average hours per week. Wage earners are obtained from the *Census of Manufactures* for odd years. For even years the index of employment of the National Industrial Conference Board is used to interpolate. Average hours per week for 1920–36 are from the National Industrial Conference Board. For 1919 a rough estimate was made, based on Census prevailing hours.

[2] Value of output from the Census is deflated by the index of paper and pulp prices of the Bureau of Labor Statistics as given in the *Survey of Current Business*. The even years, 1922–36, are obtained by interpolating with the monthly shipments of paper board reported in the *Survey of Current Business*. 1920 was interpolated with the Federal Reserve Board index of paper and printing activity.

The formula.—The following formula was derived by using the data for the years 1919–20 and 1922–32:

$$\underset{\text{(Thousands)}}{\text{Calculated man-hours per week}} = 28.52\ (0.9642)^{\text{year}-1926} \times \underset{\text{(Millions 1926 dollars)}}{(\text{output})^{0.7957}}$$

The average residual for the years covered by the analysis 1919–20 and 1922–32, is 2.4 percent, with a maximum of 6.8 percent occurring in 1930. The average residual for the extrapolated years, 1933–36, is 1.5 percent, with a maximum of −2.4 percent occurring in 1933.

The amount of variation explained is 89 percent.

Summary No. 123b
Paper Products—Consumption

Method used.—Consumption of paper products was related to consumer income and a time trend. An exponential relationship was fitted to the data for the years 1919–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption (deflated value: millions of 1926 dollars)[1]	Consumer income (billions of 1936 dollars)[2]
1919	401.7	46.6
1920	464.0	47.0
1921	375.8	42.3
1922	466.2	48.8
1923	534.6	54.8
1924	531.7	55.4
1925	546.5	57.0
1926	634.3	58.3
1927	690.7	58.9
1928	711.3	62.2
1929	779.7	65.3
1930	679.8	60.4
1931	639.9	54.6
1932	566.0	46.7
1933	622.8	48.2
1934	674.2	54.0
1935	805.2	56.9
1936	934.2	63.9

[1] Consumption assumed equal to production. See summary No. 123a. Paper production—manpower.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1919–32:

$$\underset{\text{(Millions 1926 dollars)}}{\text{Calculated consumption}} = 6.761\ (1.0235)^{\text{year}-1926} \times \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})}^{1.11183}$$

The average residual for the years covered by the analysis, 1919–32, is 3.6 percent, with a maximum of 9.3 percent in 1920.

The average residual for the extrapolation years, 1933 36, is 5.7 percent, with a maximum of 8.1 percent in 1935.

The amount of variation explained is 95 percent.

Summary No. 124a
Furniture and Related Products—Manpower

Method used.—Man-hours was related to production and a time trend. A linear formula with an additive exponential time trend was fitted graphically. The fit obtained with the use of this type of formula, although not too good, was somewhat better than that given by the usual exponential type of formula and so the additive formula is given below.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hour (millions)[1]	Deflated value of output (millions 1926 dollars) [2]
1919	7.22	506
1920	7.55	483
1921	5.73	424
1922	7.40	579
1923	8.36	666
1924	8.00	669
1925	8.85	831
1926	9.34	955
1927	9.24	906
1928	8.89	959
1929	9.34	998
1930	6.72	702
1931	5.23	548
1932	3.63	387
1933	3.89	396
1934	4.00	397
1935	5.22	549

[1] Computed by multiplying employment by average hours per week. Wage earners obtained from the *Census of Manufactures* for odd years; even years interpolated using the Bureau of Labor Statistics employment index. Average hours per week for 1933–36 are from the Bureau of Labor Statistics; for 1920–31 from the National Industrial Conference Board; for 1919 obtained by splicing Census prevailing hours at 1923; for 1932 an average of Bureau of Labor Statistics and National Industrial Conference Board data is used.

[2] Value of products for odd years obtained from the Census and interpolated in even years using the Seidman & Seidman index of furniture manufactures; the resulting series is deflated by the Bureau of Labor Statistics furniture price index. 1920 value of products was interpolated using the average shipments per firm in the southeastern district, compiled by the Southern Furniture Manufacturers Association as given in the 1932 Supplement of the *Survey of Current Business*.

The formula.—The following formula was derived from the data for 1919–32:

$$\underset{\text{(Millions per week)}}{\text{Calculated man-hours}} =$$

$$0.00878\ \underset{\text{(Millions 1926 dollars)}}{(\text{production deflated value})} + 1.67\ (0.8918)^{\text{year}-1926} - 0.507$$

The average residual for the years 1919–32 is 4.2 percent, with the maximum of 8.6 percent occurring in 1923.

The average residual for the extrapolated years, 1933–35, is 6.7 percent with the maximum of 9.3 percent occurring in 1934.

The amount of variation explained is 95 percent.

Summary No. 124b
Furniture and Related Products—Consumption

Method Used.—The consumption in this segment is taken to be the same as production since data on stocks are not available.

Consumption is related to consumer income, deflated value of construction, and a time trend. An exponential formula was fitted to the data for the years 1919–32.

The data.—The following table shows the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (millions 1926 dollars)	Consumer [2] income (billions 1936 dollars)	Construction,[3] deflated value (billions 1929 dollars)
1919	506	46.6	3.06
1920	483	47.0	2.55
1921	424	42.3	2.89
1922	579	48.8	4.55
1923	666	54.8	4.33
1924	669	55.4	4.94
1925	831	57.0	6.65
1926	955	58.3	7.06
1927	906	58.9	6.93
1928	959	62.2	7.51
1929	998	65.3	6.44
1930	702	60.4	5.26
1931	548	54.6	3.86
1932	387	46.7	1.85
1933	396	48.2	1.76
1934	397	54.0	2.05
1935	549	56.9	2.42

[1] Census figures in value of furniture and related products deflated by the wholesale price of furniture. The noncensus year values are interpolated by an index of furniture production given in Department of Commerce Marketing Research Division, *Furniture Manufacturing Wholesale;* July 1937 based on data furnished by Seidman & Seidman.

[2] See table I of this Appendix.

[3] See data given in summary No. 500a.

The formula.—The following formula was derived using the data for the years of the period 1919-32.

$$\underset{\text{(Millions 1926 dollars)}}{\text{Calculated consumption}} = 2.335\ \ (0.9901)^{\text{year}-1926} \times \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})}^{1.2635}\ \underset{\text{(Millions 1929 dollars)}}{(\text{construction output})}^{0.3995}$$

The average residual for the period 1919 32 is 4.7 percent, with the maximum of 9.9 percent occurring in 1926.

The average residual for the extrapolated period, 1933–35, is 9.5 percent, with the maximum of −10.6 percent occurring in 1934.

The amount of variation explained is 96 percent.

Summary No. 125a
Miscellaneous Lumber Products—Manpower

Method used.—Man-hours was related to industrial production and a time trend for the years of the period 1925–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Industrial production [2] (1923–1925=100)
1925	6.98	104
1926	7.21	108
1927	7.10	106
1928	7.18	111
1929	7.38	119
1930	5.96	96
1931	4.95	81
1932	3.69	64
1933	4.19	76
1934	4.28	79
1935	5.31	90
1936	6.21	105

[1] Computed by multiplying employment by hours per week. Employment is Census data interpolated by Bureau of Labor Statistics indexes. Hours per week are computed from Census prevailing hours in 1919, 1921, 1923, and 1929; data for 1932–36 are from Bureau of Labor Statistics; other years are straight line interpolations.

[2] Federal Reserve Board. See table I of this Appendix.

The formula.—The following formula was obtained by using the data for the years of the period 1925–32:

$$\underset{\text{(Millions per week)}}{\text{Calculated man-hours}}$$

$$0.05341\ (0.9812)^{\text{year}-1929}\ \underset{(1923\text{-}25=100)}{(\text{industrial production})^{1.0356}}$$

The average residual for the years of the period covered, 1925–32, is 1.3 percent, with the maximum of −2.3 percent occurring in 1929.

The average residual for the years of the extrapolated period, 1933–36, is 5.6 percent, with the maximum of 7.3 percent occurring in 1936.

The amount of variation explained is 99.3 percent.

Summary No. 126a
Printing and Publishing
(Newspaper and Periodical)—Manpower

Method used.—Man-hours in the industry was related to production and a time trend. A modified exponential relationship was fitted to the data for the years of the period 1920–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1920	83.4	56.3
1921	80.6	53.7
1922	84.2	64.6
1923	87.8	71.9
1924	89.4	74.9
1925	89.2	79.2
1926	90.8	91.2
1927	92.1	90.2
1928	92.9	94.1
1929	100.0	100.0
1930	97.9	94.1
1931	87.5	85.5
1932	77.5	74.9
1933	72.7	71.1
1934	73.0	81.1
1935	73.8	87.4

[1] Preliminary Report on *Productivity in the Printing and Publishing Industry. Newspaper and Periodicals.* National Research Project. Works Progress Administration. Based on hours per week given by the National Industrial Conference Board 1920–32, and Bureau of Labor Statistics 1932–35; employment from *Census of Manufactures* for the odd years interpolated by the Bureau of Labor Statistics employment indexes.

[2] Loc. cit., based on Census value of products weighted by the unit values in 1929 and interpolated by data on wood pulp consumption as given in the *Survey of Current Business.*

The formula.—The following formula was derived by using the data for the years of the period 1920–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} =$$

$$[0.6287\ \underset{(1929=100)}{(\text{production})} + 37.7]\ [-0.02\ (\text{year}-1926)+1.02]$$

The average residual for the years of the period 1920 to 1932 was 2.7 percent, with a maximum of 7.5 percent occurring in 1930.

The index of man-hours for each of the 3 years, 1933–36 was calculated from the formula. The average residual for the extrapolated years was 3.2 percent, with a maximum of −.5.1 percent occurring in 1935.

The average amount of variation explained is 73 percent.

Summary No. 126b
Printing and Publishing
(Newspaper and Periodical)—Consumption

Method used.—Consumption of newspapers and periodicals was related to an average of consumer income and the Federal Reserve Board index of production, and a time trend.

Data used.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption of newspapers and periodicals [1] (1929=100)	Average consumer income and index of production current and previous year [2] (1923–25=100)
1920	56.3	85.0
1921	53.7	79.0
1922	64.6	79.0
1923	71.9	93.0
1924	74.9	98.5
1925	79.2	100.0
1926	91.2	104.5
1927	90.2	106.0
1928	94.1	109.0
1929	100.0	115.0
1930	94.1	110.0
1931	85.6	96.0
1932	74.9	82.0
1933	71.1	77.5
1934	81.1	84.5
1935	87.4	92.0

[1] See footnote 2 summary 126a.

[2] The arithmetic mean of consumer income (see table 1) on the base 1923–25=100 and Federal Reserve Board index of Industrial production 1923–25=100. An average of the current and previous years of this combined index was used in the analysis.

The formula.—The following formula was derived from the data for the period 1920–32:

$$\underset{(1929=100)}{\text{Calculated consumption}} =$$

$$[1.067\ \underset{(1923\text{-}25=100)}{(\text{average consumer income and industrial production})}$$

$$-22.67]\ [0.0217\ (\text{year}-1926)+0.990]$$

The average residual in the covered period 1920–32 is 4.3 percent, with the maximum of 16.2 percent occurring in 1922.

The average residual in the extrapolated period 1933–35 is 3.1 percent, with the maximum of 3.8 percent occurring in 1933.

The amount of variation explained is 0.91 percent.

Summary No. 126.1a
Printing and Publishing
(Book, Music, and Job)—Manpower

Method used.—Man-hours in book, music, and job printing was related to the deflated value of the output and a time trend. An exponential relationship was derived from the data for the years 1921–32.

The data.—The following table gives the data used in the analysis:

Man-power and related factors

Year	Man-hours per week [1] (millions)	Deflated value of product [2] (millions of 1936 dollars)
1921	5.45	561
1922	5.88	622
1923	6.05	628
1924	6.14	669
1925	6.29	672
1926	6.61	741
1927	6.68	753
1928	6.64	792
1929	6.97	841
1930	6.62	792
1931	5.64	740
1932	4.41	606
1933	3.97	562
1934	4.41	610
1935	4.86	711
1936	5.40	846

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[1] Man-hours: This is the product of average actual hours per week as given by the National Industrial Conference Board, and employment from *Census of Manufactures* for the odd years interpolated by the Bureau of Labor Statistics employment indexes for the even years.

[2] Deflated value of output: Value of output according to the *Census of Manufactures* was interpolated by the gross income of book, music, and job printing corporations as given in the *Statistics of Income*, Bureau of Internal Revenue, and deflated by the cost of living index of the Bureau of Labor Statistics.

The formula.—The following formula was obtained from the data for 1921–32:

$$\underset{\text{(Millions per week)}}{\text{Man-hours}}=$$

$$0.0025(0.9719)^{\text{year}-1927}\ \underset{\text{(Millions of 1936 dollars)}}{(\text{deflated value of product})^{1.1886}}$$

The average residual for the years covered by the analysis, 1921–32, is 1.7 percent, with the maximum of 3.6 percent occurring in 1924.

The average residual for the extrapolated years, 1933–36, is 3.6 percent, with the maximum of −7.4 percent occurring in 1936.

The amount of variation explained is 96 percent.

Summary No. 126.1b
Printing and Publishing
(Book, Music, and Job)—Consumption

Method used.—Deflated value of output was related to consumer income and a time trend. A modified exponential relationship was fitted to the data for the years 1919–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Output [1] (millions of 1936 dollars)	Consumer income[2] (billions of 1936 dollars)
1919	499	46.6
1920	554	47.0
1921	561	42.3
1922	622	48.8
1923	628	54.8
1924	669	55.4
1925	672	57.0
1926	741	58.3
1927	753	58.9
1928	792	62.2
1929	841	65.3
1930	792	60.4
1931	740	54.6
1932	606	46.7
1933	562	48.2
1934	610	54.0
1935	711	56.9
1936	846	63.9

[1] The value of products was obtained from the *Census of Manufactures* for odd years; even years were interpolated using the gross income of corporations in printing, publishing, and allied industries as given in Statistics of Income (Bureau of Internal Revenue). The resulting series was deflated by the cost of living index (see table I).

[2] See table I of this Appendix.

The Formula.—The following formula, the linear factors being graphically determined, was derived from the data for the years 1919–32:

$$\underset{\text{(Millions 1936 dollars)}}{\text{Calculated output}}=[1+0.0078\,(\text{year}-1926)]\times$$

$$[12+12.42\ \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})}]$$

The average residual for the years covered by the analysis, 1919–32, is 3.6 percent, with a maximum of −11.4 percent occurring in 1919.

The average residual for the extrapolated years, 1933–36, is 10.3 percent, with a maximum of −16.4 percent occurring in 1934.

The amount of variation explained is 90 percent.

Summary No. 126.2a
Printing and Publishing:
Allied Industries—Manpower

Method used.—Employment was related directly to a 2-year average (current and preceding year) of consumer income. No time trend was indicated by the graphical analysis; the linear form appeared to give a somewhat better fit than the power formula.

The data.—The following table presents the data used in the analysis for the years of the period 1923–32:

Manpower and related factors

Year	Employment (thousands)[1]	Consumer income average current and preceding year (billions 1936 dollars) [2]
1923	60.6	51.8
1924	62.6	55.1
1925	62.8	56.2
1926	64.7	57.6
1927	65.9	58.6
1928	69.5	60.6
1929	76.9	63.6
1930	71.4	62.8
1931	62.3	67.5
1932	53.3	50.6
1933	50.3	47.4
1934	56.1	51.1
1935	59.5	55.4
1936	64.8	60.4

[1] *Census of Manufactures* data interpolated by data derived from Bureau of Labor Statistics employment indexes.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1923–32:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}}=-16.4+1.412\times$$

$$\underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income, average of current and preceding year})}$$

The average residual for the years of the period covered, 1923–32, is 2.3 percent, with the maximum of 6.9 percent occurring in 1923.

The average residual for the years of the extrapolated period, 1933–36, is 2.6 percent, with the maximum of −5.9 percent occurring in 1936.

The amount of variation explained is 89 percent.

Summary No. 127a
Rubber Tires and Tubes—Manpower

Method used.—Manpower was related to production of tires and tubes and time by the method of least squares using a formula of the exponential type. The exponent for production was very close to unity so the analysis was reworked by fitting a time trend to the ratio of manpower to production.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours (1929=100) [1]	Production (1923–25=100)[2]
1923	86.8	86
1924	83.5	98
1925	96.0	116
1926	93.7	116
1927	93.7	120
1928	103.8	144
1929	100.0	135
1930	69.5	100
1931	49.7	96
1932	38.8	78
1933	45.8	88
1934	51.8	92
1935	51.1	97
1936	55.8	115

[1] 1926–34 *N. R. A. Evidence Study No. 36*, p. 86; sources: 1929–31 National Industrial Conference Board and 1932–34 Bureau of Labor Statistics *Trend of Employment*, computed and adjusted to census totals by N. R. A. Division of Research and Planning. 1921–25 another man-hour index spliced on at 1926; source: *Labor Productivity in the Auto Tire Industry*, Bureau of Labor Statistics Bulletin No. 585 by Boris Stern, p. 4. This series represents direct labor only. The data for the years 1935 and 1936 were spliced on by means of an index of man-hours derived by multiplying Bureau of Labor Statistics average hours in the tire and tube industry by Bureau of Labor Statistics employment in the tire and tube industry and converting the resulting man-hours series into an index on a 1929 base and adjusted to the census totals in the same industry through 1935.

[2] Federal Reserve Board index of production of rubber tires and tubes as given in the *Survey of Current Business*, 1936 Supplement, p. 7—Includes production for both domestic and foreign markets.

The formula.—The formula obtained by using the data for the period of the years 1923–32 is as follows:

$$\underset{(1929=100)}{\text{Calculated man-hours/week}} = (0.371+0.2293\ (0.8874)^{\text{year}-1931})\ \underset{(1923\text{-}25=100)}{(\text{production})}$$

The average residual for the years of the period 1923–32 is 7.2 percent, with the maximum of −13.7 percent occurring in 1931.

The average residual for the years of the extrapolated period, 1933–36, is 4.1 percent, with the maximum of 5.9 percent occurring in 1934.

The amount of variation explained is 92 percent.

Summary No. 127b
Rubber Tires and Tubes—Consumption

Method used.—The consumption of tires and tubes was related to the consumption of gasoline and the change during the year in the total number of automobiles registered.[1]

An estimate was first made of the number of tires going to the replacement market; this series was divided by the consumption of gasoline and an exponential time trend was fitted to this ratio.

The total consumption of tires and tubes was than related to the change in registrations and the product of the consumption of gasoline and the time trend thus obtained. A linear relationship was used and in this final analysis the years 1927 and 1928 were omitted, it being felt that the disturbance caused by the Ford shutdown made these years unrepresentative; only the years 1921–26 and 1929–32 were used.

The data.—The following table presents the data used in the analysis:

Consumption and related factors

Year	Domestic shipments of tires and tubes; value at average prices, 1923–33[1] (millions of dollars)	Estimated tires and tubes worn out; value at average prices, 1923–33[2] (millions of dollars)	Gasoline consumption[3] (millions of barrels)	Increase in registrations during year[4] (thousands)
1921	301.4	246.8	108	1,231
1922	409.8	325.7	128	1,775
1923	457.4	308.1	157	2,854
1924	501.0	387.2	187	2,503
1925	587.9	461.5	226	2,342
1926	574.7	458.8	264	2,064
1927	616.3	551.4	300	1,032
1928	694.2	606.4	332	1,460
1929	673.5	547.6	376	2,008
1930	511.9	484.0	395	44
1931	475.9	461.1	403	−712
1932	379.9	372.7	374	−1,718
1933	413.5	399.7	377	−272
1934	436.5	388.3	407	1,108
1935	465.5	377.2	433	1,279
1936	522.7	423.7	480	1,990

[1] Domestic shipments of casings and inner tubes obtained from the *Survey of Current Business*. Domestic shipments of solid and cushion tires obtained by correcting *Commerce Yearbook* data for imports and exports. An average price for each type was obtained by averaging prices obtained from *Census of Manufactures* value and quantity data for the odd years 1923–33. Series were raised to estimated 100 percent coverage, multiplied by the respective average prices, and the products summed.

[2] This series is obtained from the previous one by deducting for tires shipped to equip new cars and adding tires worn out on scrapped cars. Estimated average number of tires and tubes per car is multiplied by the number of cars and the average value per unit used in making up the aggregate. The number of cars produced and scrapped is obtained from *Automobile Facts and Figures* (Automobile Manufacturers Association, New York) and the *Survey of Current Business*.

[3] See summary No. 131c, Gasoline consumption.

[4] *Automobile Facts and Figures* (Automobile Manufacturers Association, New York). Year to year change in total registrations as of Dec. 31 each year.

The formula.—The following formula was obtained from the data for the period 1921–32:

$$\underset{(\text{Millions of dollars})}{\text{Consumption of tires and tubes}} = -58.44+45.714\ \underset{(\text{Millions})}{(\text{change in registrations during year})} + 2.0758\ (0.9270)^{\text{year}-1926}\ \underset{(\text{Millions of barrels})}{(\text{gasoline consumption})}$$

The average residual for the years covered by the analysis is 4.5 percent, with a maximum of −7.3 percent in 1921.

The average residual for the extrapolated years, 1933–36, is 4.2 percent, with a maximum of 6.1 percent in 1933.

The amount of variation explained is 94 percent.

Summary No. 128a
Rubber Products Other than Tires and Tubes—Manpower

Method used.—The factors related to man-hours are deflated value of output, and a time trend.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours[1] (10,000 per week)	Deflated value of output[2] (millions 1931 dollars)
1921	209	147
1922	280	184
1923	286	213
1924	228	202
1925	268	228
1926	276	232
1927	289	252
1928	304	269
1929	295	280
1930	230	238
1931	191	208
1932	150	179
1933	174	208
1934	189	231
1935	191	260

[1] Computed by multiplying employment by average weekly hours. Employment is obtained from the census for odd years, interpolated by Bureau of Labor Statistics employment index for the even years 1924–36 and by National Industrial Conference Board data for 1922. Average hours per week are from National Industrial Conference Board and cover a sample of the entire rubber industry.

[2] The deflated value series is obtained for census years by deflating the total value of output by a price index derived from census data on value and quantity of rubber shoes and overshoes, rubber-soled canvas shoes, rubber heels, rubberized fabrics, rubber belting, and rubber hose, weighted according to value in 1931. The values for the intercensal years are obtained by interpolation using the consumption of crude rubber as given by the Rubber Manufacturers Association in the *Commerce Year Book* for years 1921–32, and from the Bureau of Foreign and Domestic Commerce for the latest years 1933, 1934, and 1935. The figures exclude rubber used for tires and tubes.

The formula.—The following formula was derived from the data for the years of the period 1921–32:

$$\underset{(\text{Ten thousand per week})}{\text{Calculated man-hours}} = 0.5025\ (0.95193)^{\text{year}-1927}\ \underset{(\text{Millions of 1931 dollars})}{(\text{deflated output})}^{1.147163}$$

The average residual for the period 1921–32 is 3.0 percent, with the maximum of −11.3 percent occurring in 1924.

The average residual for the extrapolated period, 1933–35, is 3.0 percent, with the maximum of −4.5 percent occurring in 1935.

The amount of variation explained is 94 percent.

Summary No. 128b
Rubber Products Other Than Tires and Tubes—Consumption

Method used.—The deflated value of rubber products other than tires and tubes produced was related to the Federal Reserve Board index of industrial production and time by an exponential formula for the years of the period 1921–32.

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[1] The tire market was considered divided into two parts—tires sold to replace tires worn out by use, either on the same car or on a car sold to replace it, and tires representing a net addition to the stock of tires in use. The number of tires worn out will be proportional to the mileage driven during the year, with a time trend representing the increased life of the tire. Gasoline consumption is taken as a convenient proxy variable for mileage—conveniently weighting more heavily the mileage of heavier vehicles. The number of tires in use is roughly proportional to the number of vehicles registered, so that the expansion market may be represented by the net increase in registrations.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Years	Deflated value of rubber products other than tires and tubes [1] (millions of 1931 dollars)	Industrial production [2] (1923–25=100)
1921	130	67
1922	165	85
1923	191	101
1924	180	95
1925	202	104
1926	205	108
1927	230	106
1928	245	111
1929	256	119
1930	221	96
1931	196	81
1932	172	64
1933	203	76
1934	225	79
1935	250	90

[1] Deflated value of outpnt obtained as explained in footnote 2, summary 128a, adjusted for exports and imports of all rubber products excluding tires and tubes; foreign trade data obtained from the Bureau of Foreign and Domestic Commerce.
[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the period 1921–32:

$$\underset{(\text{Millions of 1931 dollars})}{\text{Calculated deflated value of products}} = 5.720\ \underset{(1923\text{-}25=100)}{(\text{industrial production})}^{0.782985}\ (1.0288)^{\text{year}-1927}$$

The largest single residual for the fitted period was −5.5 percent in 1926 and the average for the whole fitted period 1921–32 was only 2.1 percent.

The average residual for the extrapolated years 1933–35 is 3.0 percent, with the largest residual for any single extrapolated year 5.0 percent in 1934.

The amount of variation explained is 97 percent.

Summary No. 129a
Chemicals—Manpower

Method used.—The index of man-hours was related to an index of production and a time trend. An exponential relationship was fitted to the data for the years of the period 1919–32. The trend has been changed by the use of a modified exponential relationship.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1919	120. 2	49. 8
1920	112. 2	60. 1
1921	81. 4	40. 2
1922	101. 1	51. 3
1923	108. 3	64. 3
1924	81. 9	59. 1
1925	98. 2	66. 3
1926	96. 2	76. 3
1927	93. 9	75. 2
1928	93. 9	92. 3
1929	100. 0	100. 0
1930	87. 5	90. 5
1931	71. 5	78. 9
1932	60. 8	61. 7
1933	66. 3	77. 9
1934	75. 2	87. 7
1935	75. 8	91. 3

Formula.—The following formula was derived from the data for 1919–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 5.13\ [0.5222+0.4378(0.8792)^{\text{year}-1926}]\ \underset{(1929=100)}{(\text{production})}^{0.6796}$$

The average residual for the years covered by the analysis, 1919–32, is 4.4 percent.

The maximum residual for the years covered by the analysis, 1919–32, is 8.4 percent in 1925.

The average residual for the extrapolated years, 1933–35, is 3.8 percent.

The maximum residual for the extrapolated years, 1933–35, is −4.3 percent in 1933.

The amount of variation explained is 89 percent.

Summary No. 129b
Chemicals—Consumption

Method used.—Consumption of chemicals was related to an average of consumer income and the Federal Reserve Board index of industrial production. A graphical method was used and a linear function fitted. The linear function gave a somewhat better fit than the usual power formula.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (1929=100)	Average industrial production and consumer income [2] (1923–25=100)
1923	64. 1	100
1924	58. 1	97
1925	66. 6	103
1926	76. 4	106
1927	75. 2	106
1928	92. 2	112
1929	100. 0	118
1930	89. 7	102
1931	78. 2	90
1932	61. 3	74
1933	77. 8	81
1934	87. 5	88
1935	90. 7	96

[1] The production series given in summary 129a was adjusted for imports and exports as given in the *Statistical Abstract of the United States.*
[2] Consumer income (see table I) is reduced to a 1923–25 base; this is combined with the Federal Reserve Board index of industrial production, each series being weighted equally.

The formula.—The following formula was obtained from the data for the years of the period 1923–32:

$$\underset{(1929=100)}{\text{Calculated consumption}} = 1.07\ \underset{(1923\text{-}25=100)}{(\text{consumer income and industrial production})} + 3.22\,(\text{year}-1928) - 30.1$$

The average residual for the years 1923–32 is 3.4 percent, with a maximum of 6.1 percent occurring in 1927.

The average residual for the extrapolated years, 1933–35, is 5.5 percent, with a maximum of 7.0 percent occurring in 1933.

The amount of variation explained is 93 percent.

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[1] Man-hours: For census years the total number of wage earners in this segment was obtained by deducting fertilizers and paints and varnish from the chemical group of the Census of Manufactures. An index of employment was compiled for the years of the period 1923–36 from Bureau of Labor Statistics indexes of employment in chemicals, cottonseed, drugs, explosives, and soap, weighted according to average number of employees in 1923–25. Similarly an average was computed for the data given on average hours of labor for the years 1932–36. The employment series was used to interpolate census employment by the geometric mean of ratios method for the even years 1924–36. The years 1920 and 1922 were similarly interpolated using National Industrial Conference Board data on chemicals employment. Average hours per week was obtained from the above Bureau of Labor Statistics average for 1933–36, and from National Industrial Conference Board for 1920–31. For 1932 an average of the 2 was used. For 1919 an average computed from census prevailing hours was spliced to National Industrial Conference Board data at 1921. Average hours per week was then multiplied by employment and reduced to an index.

[2] Production: For census years 1919–33 an index based on census output data for various items weighted according to 1929 value given by the National Research Project in a preliminary unpublished report, *Productivity in the Chemicals Industry* was used. This was interpolated and extrapolated for the remaining years 1920–35 by series on tons of revenue chemicals and explosives freight originated on United States railroads, as given in the *Statistical Abstract of the United States.*

Summary No. 129.1a
Paints and Varnish—Manpower

Method used.—Man-hours was related to production and a time trend for the years of the period 1924–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1924	81.5	71.0
1925	88.8	78.7
1926	86.1	79.6
1927	93.7	87.6
1928	95.2	96.2
1929	100.0	100.0
1930	80.0	81.6
1931	66.2	70.6
1932	56.1	55.4
1933	61.6	60.4
1934	66.4	70.7
1935	72.8	86.6

[1] Preliminary report on *Productivity in the Paint and Varnish Industry* (National Research Project of Works Progress Administration). Based upon Bureau of Labor Statistics employment data, and National Industrial Conference Board and Bureau of Labor Statistics data for hours per week.

[2] Loc. cit. based upon census data on output of 19 major products in the industry, each weighed by its unit value in 1929.

The formula.—The following formula was derived from the data for the years of the period 1924–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 1.878\,(0.97564)^{\text{year}-1928}\,\underset{(1929=100)}{(\text{production})^{0.864}}$$

The average residual for the period covered, 1924–32, is 1.8 percent, with the maximum of −4.1 percent occurring in 1931.

The average residual for the extrapolated period, 1933–35 is 4.4 percent, with the maximum of 7.3 percent occurring in 1933

The amount of variation explained is 99 percent.

Summary No. 129.1b
Paints and Varnish—Consumption

Method used.—The factor which was related to paints and varnish consumption was simply consumer income. The index of building construction was also considered in the analysis but appeared to have a negligible effect. No time trend was apparent. The linear formula gave the most satisfactory results.

The data.—The following table gives the data used in the final analysis:

Consumption and related factors

Year	Production [1] (1929=100)	Consumer income [2] (billions 1936 dollars)
1919	49.9	46.6
1920	54.6	47.0
1921	44.6	42.3
1922	59.3	48.8
1923	67.5	54.8
1924	71.0	55.4
1925	78.7	57.0
1926	79.6	58.3
1927	87.6	58.9
1928	96.2	62.2
1929	100.0	65.3
1930	81.6	60.4
1931	70.6	54.6
1932	55.6	46.7
1933	60.4	48.2
1934	70.7	54.0
1935	86.6	56.9

[1] See summary 129.1a, footnote 2.

[2] See table 1 of this Appendix.

The formula.—The following formula was derived for the years 1919–32:

$$\underset{(1929=100)}{\text{Calculated consumption}} = -61.3 + 2.458\,\underset{(\text{Billions 1936 dollars})}{(\text{consumer income})}$$

The average residual for the years 1919–32 is 3.7 percent, with a maximum of −8.3 percent in 1923.

Consumption of paints and varnish for each of the years 1933 to 1935 was calculated from the formula. The average residual for the 3 years is 5.6 percent, with a maximum of 11.7 percent in 1935.

The amount of variation explained is 95 percent.

Summary No. 131a
Petroleum Refining—Manpower

Method used.—Employment in the drilling of oil and gas wells was related by a graphic regression line to oil run to stills in the United States for the years of the period 1919–32. The time trend was found in a preliminary analysis to be insignificant, so a formula was derived directly from the regression line.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment [1] (thousands)	Oil run to stills [2] (millions of barrels)
1919	58.9	362
1920	----------	----------
1921	63.2	443
1922	----------	----------
1923	66.7	581
1924	62.3	644
1925	65.3	740
1926	71.8	779
1927	71.2	829
1928	67.8	913
1929	80.6	988
1930	80.9	927
1931	68.8	895
1932	64.0	820
1933	69.0	861
1934	77.6	896
1935	77.4	966
1936	78.8	1,069

[1] *Census of Manufactures*, 1919, vol. I, p. 216; 1933, p. 368; 1935 summary (mimeographed). Interpolated in noncensus years by Bureau of Labor Statistics index of employment.

[2] Bureau of Mines: 1919–29, *Petroleum Refining Statistics, 1929, Bulletin No. 339*, p. 24; 1929–31, *Crude Petroleum and Petroleum Products in 1931*; 1932–36, *Minerals Yearbook, 1937*, p. 975. 1936 figures revised by Bureau of Mines; not published. Data include both foreign and domestic oils. Unit: millions of barrels of 42 U. S. gallons.

The formula.—The formula obtained from the data for the years of the period 1919–32 is as follows:

$$\underset{(\text{thousands})}{\text{Calculated employment}} = 44 + 0.032938\,\underset{(\text{Millions of barrels})}{(\text{oil run to stills})}$$

The average residual for the years of the period 1919–32 is 5.6 percent, with the maximum of −9.9 percent occurring in 1932.

The average residual for the years of the extrapolated period, 1933–36, is 2.7 percent with the maximum of 5.4 percent occurring in 1934.

The amount of variation explained is 59 percent.

Summary No. 131b
Petroleum Refining—Consumption

Method used.—Oil run to stills was related to consumer income by fitting empirical regression lines to scatter diagrams for the years of the period 1919–32. The linear formula was fitted to the data because it gave results which were slightly better than those obtained by the usual power formula, although in any case the results are far from satisfactory.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Oil run to stills [1] (millions of barrels)	Consumer income [2] (billions of 1936 dollars)
1919	362	46.6
1920		
1921	413	42.3
1922		
1923	581	54.8
1924	644	55.4
1925	740	57.0
1926	779	58.3
1927	829	58.9
1928	913	62.2
1929	988	65.3
1930	927	60.4
1931	895	54.6
1932	820	46.7
1933	861	48.2
1934	896	54.0
1935	966	56.9
1936	1,069	63.9

[1] *Petroleum Refining Statistics, 1929* (Bureau of Mines, Bulletin 339), p. 24; *Crude Petroleum and Petroleum Products in 1931* (Bureau of Mines); *Minerals Yearbook, 1937* (Bureau of Mines), p. 975. Data include foreign and domestic oils run to stills in the United States.

[2] See table I of this Appendix.

The formula.—The following formula was obtained using the data for the years of the period 1919–32:

$$\underset{\text{(Millions barrels)}}{\text{Calculated oil run to stills}} = -37.5 + 13.93728\ \underset{\text{(Billions 1936 dollars)}}{\text{(consumer income)}} + 33.33\ (\text{year} - 1926)$$

The average residual for the years of the period 1919–32 is 3.4 percent, with the maximum of 15.0 percent occurring in 1921.

The average residual for the years of the extrapolated period, 1933–36, is 7.0 percent, with the maximum of −9.9 percent occurring in 1936.

The amount of variation explained is 99 percent.

Summary No. 131c
Gasoline Consumption

Method used.—Gasoline consumption was first expressed by a linear equation involving a trend factor, equated cars in use, and consumer income, using the data for the years 1919–32. From the partial relationships the scatter of points above and below the lines indicated some curvilinearity. The exponential form was therefore used. The scatter of points about the time trend indicated that a curvilinear trend would give a better statistical relationship; the use of a curvilinear time trend is also justified by the consideration of the types of cars produced during the period, and other developments. Originally the various factors were put on a per capita basis. Finally the equation was reworked with totals, and the time trend was allowed to take care of the influence ascribable to population increase.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Gasoline consumption [1] (million barrels)	Equated cars in use [2] (millions)	Consumer income [3] (billions 1936 dollars)
1920	101	11.6	47.0
1921	108	13.5	42.3
1922	128	15.5	38.8
1923	157	18.5	54.8
1924	187	22.3	55.4
1925	226	25.9	57.0
1926	264	28.9	58.3
1927	300	30.9	58.9
1928	332	32.5	62.2
1929	376	34.5	65.3
1930	395	36.0	60.4
1931	403	35.8	54.6
1932	374	34.8	46.7
1933	377	34.8	48.2
1934	407	25.6	54.0
1935	433	30.6	56.9

[1] *Minerals Yearbook* (U. S. Department of the Interior, Bureau of Mines), 1937, p. 1029.

[2] Derived from registrations as reported in *Facts and Figures* (New York: Automobile Manufacturers Association, 1937) p. 16. Passenger cars weighted by 1; trucks weighted by 5.

[3] See table I of this Appendix.

The formula.—The following formula was derived from the data for the period 1920–32:

$$\underset{\text{(millions barrels)}}{\text{Calculated gasoline consumption}} = 19.535\left(1.22 + \frac{-0.412}{1.22 + .047(1.55)^{\text{year}-1920}}\right) \times \underset{\text{(Billions 1936 dollars)}}{\text{(consumer income)}}^{0.345} \times (1.042)^{(\text{cars in use, millions})}$$

The average residual for the period 1920–32 is 0.8 percent, with the maximum of −2.2 percent occurring in 1930.

The average residual for the extrapolated period, 1933–35, is 0.6 percent, with the maximum of −0.7 percent occurring in 1934 and 1935.

The amount of variation explained is 99.5 percent.

Summary No. 132a
Glass—Manpower

Method used.—Total annual man-hours in the glass industry were related to production of glass and glass products and a time trend.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929 = 100)	Deflated output [2] (millions 1926 dollars)
1919	115.6	222.7
1920	119.0	312.3
1921	79.5	161.1
1922	96.3	257.1
1923	106.7	251.5
1924	97.4	247.2
1925	101.6	285.2
1926	106.4	296.5
1927	96.9	312.7
1928	95.6	303.0
1929	100.0	316.5
1930	79.4	268.1
1931	61.4	249.5
1932	46.0	183.1
1933	53.3	210.2
1934	64.8	242.6
1935	70.5	312.0

[1] Preliminary report on *Productivity in the Glass Industry* (National Research Project of the Works Progress Administration); based upon employment data from Federal Reserve Board and Bureau of Labor Statistics, and hours data from Census prevailing hours and Bureau of Labor Statistics actual hours.

[2] Based upon *Census of Manufactures* data. Census value of products interpolated in noncensus years by value of glass sand consumed by the industry; this value was deflated by a weighted price index of glass products, see summary No. 132b, footnote 3.

The formula.—The following formula was derived from the data for the years of the period 1919–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}}= 0.8298\ (0.9533)^{\text{year}-1926}\ \underset{(\text{Millions 1926 dollars})}{(\text{deflated output})^{0.841}}$$

The average residual for the years of the period 1919–32 is 6.5 percent, with the maximum of −14.2 percent occurring in 1920.

The man-hours for the three years 1933–35 were extrapolated by means of the formula. The average residual for these 3 years is 5.9 percent, with the maximum of 13.1 percent occurring in 1934.

The amount of variation explained is 90 percent.

Summary No. 132b
Glass—Consumption

Method used.—The output of the glass industry, measured in terms of deflated value of products available for the domestic market, was related to the Federal Reserve Board index of industrial production and the deflated price of glass products over the whole period, 1919–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Deflated value of production available for domestic market (millions of 1926 dollars) [1]	Industrial production (1923–25=100) [2]	Deflated price of glass products (1926=100) [3]
1919	203.1	83	84.8
1920	297.0	87	95.0
1921	157.5	67	135.8
1922	262.4	85	104.1
1923	263.4	101	122.3
1924	256.4	95	119.9
1925	293.6	104	100.3
1926	308.2	108	100.0
1927	321.7	106	94.7
1928	308.5	111	96.4
1929	319.7	119	100.7
1930	267.9	96	109.1
1931	248.7	81	118.8
1932	182.6	64	134.9
1933	209.3	76	138.5
1934	240.7	79	125.2
1935	309.5	90	113.8

[1] Derived from value of products, "Glass", in the *Census of Manufactures.* Approximately 1 percent of the value of the products represented by the series consists of products not normally in the glass industry. For 1929 and later years the figures are sales, before 1929, production. This value series was interpolated by a graphic regression method using value of glass sand as reported in *Minerals Yearbooks* and *Mineral Resources of the United States* of the Bureau of Mines, as an interpolating series. The resulting series of value of glass products produced was corrected for imports and exports reported by the Bureau of Foreign and Domestic Commerce in the *Statistical Abstract of the United States.* The resulting series was deflated by a price series on a 1926 base derived from Bureau of Labor Statistics materials as described below.

[2] See table I of this Appendix.

[3] A price index for glass products was derived from series published by the Bureau of Labor Statistics on nappies, pitchers, tumblers, plate glass (2 series), and window glass, weighted by the weights used by Bureau of Labor Statistics in computing their group indexes, on a 1926 base. This index was used to deflate the value series described in footnote 1, and was deflated by the index of general wholesale prices on a 1926 base, published by the Bureau of Labor Statistics, to get the deflated price index.

The formula.—The formula obtained by using the data for the period of the years 1920–32 is as follows:

$$\underset{(\text{Millions of 1926 dollars})}{\text{Calculated consumption}}=18.81\ (1.008)^{\text{year}-1926}\times \underset{(1923\text{–}25=100)}{(\text{industrial production})^{0.903}}\ \underset{(1926=100)}{(\text{deflated price})^{-0.312}}$$

The average residual for the years of the period covered, 1919–32 is 6.3 percent, with the maximum of 21.6 percent occurring in 1920.

The average residual for the years of the extrapolated period, 1933–35 is 7.3 percent, with the maximum of 15.3 percent occurring in 1935.

The amount of variation explained is 83 percent.

Summary No. 133a
Cement—Manpower

Method used.—The factors which were related to man-hours in the cement industry were production of portland cement and a time trend over the years of the period 1921–32:

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (millions, per year)	Production [2] (millions of barrels)
1921	80.6	98.84
1922	85.8	114.79
1923	103.7	137.41
1924	109.8	149.36
1925	109.0	161.66
1926	110.6	164.53
1927	110.2	173.21
1928	108.3	176.30
1929	99.3	170.65
1930	90.3	161.20
1931	60.5	125.43
1932	38.5	76.74
1933	31.5	63.47
1934	37.8	77.75
1935	39.0	76.75
1936	50.5	112.65

[1] Data for 1921–25: American Engineering Council, *Safety and Production* (New York and London: Harper & Bros., 1938). Data for 1926 and 1927: Bernard H. Topkis, Labor Requirements in Cement Production, *Monthly Labor Review* (U. S. Department of Labor, Bureau of Labor Statistics, vol. 42, No. 3, March 1936). Series on productivity used as interpolating medium. Data for 1928–33: *Minerals Yearbook,* 1935 (United States Department of the Interior, Bureau of Mines, 1935); data for 1934–36, unpublished data of Bureau of Mines.

[2] Bureau of Mines, *Mineral Yearbook.*

The formula.—The following formula was derived from the data for the years of the period 1921–32:

$$\underset{(\text{Millions per year})}{\text{Calculated man-hours}}=66.1\ \{0.0814+0.9114\ (0.955)^{\text{year}-1926}\}\times \underset{(\text{Hundred millions of barrels})}{(\text{production})^{1.001587}}$$

The average residual for the period 1921–32 is 2.4 percent with the maximum of −9.3 percent occurring in 1931.

The average residual for the extrapolated period, 1933–36, is 5.3 percent, with the maximum of 12.7 percent occurring in 1934.

The amount of variation explained is 97 percent.

Summary No. 133b
Cement—Consumption

Method used.—The consumption of cement is related to an average of the consumer income for the current and 2 preceding years, to the deflated value of construction contracts, and a time trend. An exponential relationship was fitted to the data for the years 1921–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (millions barrels)	Consumer income, 3-year average [2] (billions 1936 dollars)	Construction value [3] (billions 1929 dollars)
1921	94.15	45.3	2.89
1922	116.90	46.0	4.55
1923	136.59	48.6	4.33
1924	147.18	53.0	4.94
1925	159.93	55.7	6.65
1926	164.45	56.9	7.06
1927	173.10	58.1	6.93
1928	177.30	59.8	7.51
1929	170.71	62.1	6.44
1930	159.28	62.6	5.26
1931	127.18	60.1	3.86
1932	80.93	53.9	1.85
1933	64.07	49.8	1.76
1934	75.60	49.6	2.05
1935	75.44	53.0	2.42

[1] *Minerals Yearbooks* (Bureau of Mines).
[2] See table I of this Appendix. Average of the current and 2 preceding years.
[3] See summary No. 500a (construction manpower).

The formula.—The following formula was derived from the data for the years of the period 1921–32:

$$\underset{\text{(Barrels)}}{\text{Calculated consumption}} = 565{,}200\ (0.9792)^{\text{year}-1927} \times$$

$$\underset{\text{(Billions 1936 dollars)}}{(\text{consumer income, 3-year average})}^{1.2083}\ \underset{\text{(Billions 1929 dollars)}}{(\text{construction})}^{0.4132}$$

The average residual for the years covered by the analysis, 1921–32, is 3.1 percent ,with a maximum of 11.1 percent occurring in 1932.

The average residual for the extrapolated years, 1933–35, is 7.4 percent, with a maximum of −9.6 percent occurring in 1935.

The amount of variation explained is 94 percent.

Summary No. 134a
Clay Products Other Than Pottery—Manpower

Method used.—Man-hours were related to production of clay products and a time trend using data for the years 1919–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1919	85.9	67.1
1920	92.0	73.6
1921	75.8	61.6
1922	92.9	80.3
1923	112.4	104.4
1924	110.0	99.7
1925	111.8	109.8
1926	113.7	111.2
1927	109.1	108.3
1928	101.3	102.6
1929	100.0	100.0
1930	68.5	72.9
1931	40.5	47.6
1932	21.1	22.3
1933	20.9	25.3
1934 [3]	25.5	26.7
1935 [3]	32.4	36.7

[1] Preliminary report on *Productivity in the Clay Products (Other Than Pottery) and Non-Clay Refractories Industry* (National Research Project of the Works Progress Administration). Based upon employment and hours data from Census and Bureau of Labor Statistics.

[2] Loc. cit., based upon quantity of 26 products, each product weighted by its 1929 value per unit.
[3] Preliminary.

The formula.—The following formula was derived by correlation analysis for the years 1919–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = 1.2385\ (0.9720)^{\text{year}-1926} \times$$

$$\underset{1929=100)}{(\text{production})}^{0.9598}$$

The average residual for the period 1919–32 is 2.3 percent with the maximum of 8.1 percent occurring in 1931. The average residual for the years of the extrapolated period 1933–35 is 8 percent, with the maximum of 10.4 percent occurring in 1934. Although these percentages are relatively large, the estimates may be considered fairly reliable since total man-hours had declined to such small quantities in these years.

The amount of variation explained is 99 percent.

Summary No. 134b
Clay Products Other Than Pottery—Consumption

Method used.—The consumption of clay products was related to the Federal Reserve Board index of manufacturing activity, the volume of construction activity, and a time trend. An exponential function was used to express the relationship.

The data.—The following table gives the data used in the analysis:

Consumption and related products

Year	Consumption [1] (1929=100)	F. R. B. index of manufactures [2] (1923–25=100)	Deflated value of construction [3] (billions of 1929 dollars)
1919	67.1	84	3.06
1920	73.6	87	2.55
1921	61.6	67	2.89
1922	80.3	80	4.55
1923	104.4	101	4.33
1924	99.7	94	4.94
1925	109.8	105	6.65
1926	111.2	108	7.06
1927	108.3	106	6.93
1928	102.6	112	7.51
1929	100.0	119	6.44
1930	72.9	95	5.26
1931	47.6	80	3.86
1932	22.3	63	1.85
1933	25.3	75	1.76
1934	26.7	78	2.05
1935	36.7	90	2.42

[1] See footnote 2, summary No. 134a.
[2] Federal Reserve index of production of manufactures.
[3] See footnote 2 of summary No. 500a, construction—Manpower.

The formula.—The following formula was derived from the data for the years 1919–32:

$$\underset{(1929=100)}{\text{Calculated consumption}} = 0.4886\ (0.9505)^{\text{year}-1926} \times$$

$$\underset{(1923\text{–}25=100)}{(\text{index of manufactures})}^{0.0219}\ \underset{\text{(Billions of 1929 dollars)}}{(\text{construction})}^{0.5808}$$

The average residual for the years covered in the analysis, 1919–32, is 6.2 percent, with a maximum of −15.3 percent in 1919.

The average residual for the years extrapolated, 1933–35, is 5.2 percent, with a maximum of −12.2 percent in 1935.

The amount of variation explained is 96 percent.

Summary No. 134.1a
Pottery—Manpower

Method used.—Man-hours was related to production of pottery and a time trend, using data for the years 1919–32.

The data.—The following table gives the data used in the correlation analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production, deflated value [2] (millions of 1926 dollars)
1919	80.4	75.5
1920	99.9	85.9
1921	79.7	71.4
1922	91.9	96.8
1923	104.8	113.1
1924	110.3	116.2
1925	103.8	112 0
1926	105.7	116.5
1927	103.7	113.1
1928	101.5	109.3
1929	100 0	114.3
1930	80.2	93.5
1931	63.6	80.0
1932	46.5	52.4
1933	52.0	57.9
1934	54.6	62.7
1935	61.7	79.0

[1] Derived from Bureau of Labor Statistics index of employment and actual hours. The figures for 1920 and 1922 of the employment index were interpolated by means of the index of employment in the clay products industry given in the preliminary report of the National Research Project of the Works Progress Administration on *Productivity in the Clay Products Industry*. Actual hours for 1919, 1921, 1923, and 1929 were obtained from census prevailing hours less 5 percent and for 1932–35 from Bureau of Labor Statistics. For the remaining years, hours were estimated by straight line interpolations.

[2] Based on census data for value of product, given in the National Research Project study quoted above, and from Bureau of Labor Statistics price indexes. The price index used to deflate value of product is a weighted composite of the Bureau of Labor Statistics price indexes for dinner sets, cups, plates, and closet bowls, weighted 3, 1, 1, and 6, respectively.

The formula.—The following formula was derived by correlation analysis for the years of the period 1919–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}}=$$

$$1.368\ (0.983)^{\text{year}-1926}\ \underset{\text{(Millions 1926 dollars)}}{(\text{production, deflated value})^{0.914}}$$

The average residual for the period 1919–32 is 2.9 percent, with the maximum of 8.2 percent occurring in 1928.

The extrapolated values are fairly close; the average residual for these years, 1933–35, is 4.0 percent, with the maximum of 4.6 percent occurring in 1935.

The amount of variation explained is 96 percent.

Summary No. 134.1b
Pottery—Consumption

Method used.—The consumption of pottery was related to consumer income and a time trend. The correlation analysis covered the years of the period 1921–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (millions of 1926 dollars)	Consumer income [2] (billions 1936 dollars)
1921	71.4	42.3
1922	96.8	48.8
1923	113.1	54.8
1924	116.2	55.4
1925	112.0	57.0
1926	116.5	58.3
1927	113.1	58.9
1928	109.3	62.2
1929	114.3	65.3
1930	93.5	60.4
1931	80.0	54.6
1932	52.4	46.7
1933	57.9	48.2
1934	62.7	54.0
1935	79.0	56.9

[1] With foreign trade negligible and no adequate data available on stocks, production has been taken to represent consumption. Production was based on Census value of products, given in the National Research Project study quoted in summary No. 134.1a, deflated by a price index. The price index used was a composite of Bureau of Labor statistics price indexes of dinner sets, cups, plates, and closet bowls weighted 3, 1, 1, and 6 respectively.

[2] See table I of this Appendix.

The formula.—The following formula was obtained by applying the method of least squares to the data for the years of the period 1921–32:

$$\underset{\text{(Millions 1926 dollars)}}{\text{Calculated consumption}}=$$

$$(0.01139+0.01934\ (0.9301)^{\text{year}-1927})\ \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})^{2.0006}}$$

The average residual for the years covered in the analysis is 3.8 percent, with a maximum of 6.0 percent in 1926.

The average residual for the years extrapolated, 1933–35, is 6.7 percent, with a maximum of 9.6 percent in 1935.

The amount of variation explained is 96 percent.

Summary No. 134.2a
Marble, Granite, and Other Stone and Glass Products—Manpower

Method used.—Man-hours was related to consumer income and a time trend. An exponential relationship was fitted to the data for the years 1919–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (mililons)	Consumer income [2] (billions of 1936 dollars)
1919	4.64	46.6
1920	4.56	47.0
1921	3.45	42.3
1922	4 20	48.8
1923	5.02	54.8
1924	5.06	55.4
1925	5.53	57.0
1926	5.70	58.3
1927	5.71	58.9
1928	5.51	62.2
1929	4.63	65.3
1930	3.68	60.4
1931	2.69	54.6
1932	1.67	46.7
1933	1.77	48.2
1934	2.04	54.0
1935	2.40	56.9

[1] Computed separately for marble and granite and for other stone, clay, and glass products, by multiplying employment by average hours per week. Wage earners for other stone, clay, and glass were obtained by subtracting from the total wage earners in the stone, clay, and glass group the sum of wage warners in other segments of the group. Data from *Census of Manufactures* for odd years and interpolated for even years using the Bureau of Labor Statistics indexes of employment. Average hours per week for 1932–36 are an average (unweighted) of average hours in marble, brick, cement, glass, and pottery, as given by the Bureau of Labor Statistics; for 1919, 1921, 1923, and 1929 they are derived by taking 5 percent from the Census prevailing hours; other years are obtained by linear interpolation. Wage earners for marble are obtained from the census for odd years and by interpolation with Bureau of Labor Statistics employment index for even years. Average hours for 1932–36 are obtained from the Bureau of Labor Statistics; for 1919, 1921, 1923, and 1928 by deducting 5 percent from Census prevailing hours, and for other years by straight line interpolation.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years of the period 1919–32:

$$\text{Calculated man-hours per week}=$$

$$86.16\ (0.9201)^{\text{year}-1926}\ \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})^{2.7007}}$$

The average residual for the period 1919–32 is 7.4 percent, with the maximum of 19.5 percent occurring in 1927.

The average residual for the extrapolated years, 1933–35, is 5.0 percent, with the maximum of 7.1 percent occurring in 1935.

The amount of variation explained is 92 percent.

Summary No. 135a
Fertilizer—Manpower

Method used.—Manpower is related to production and a time trend. An exponential relationship was fitted to the data for 1920 to 1932 and the time trend factor subsequently modified.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1920	136.6	92.1
1921	80.3	63.0
1922	84.4	71.8
1923	90.0	79.6
1924	82.4	81.9
1925	94.2	85.2
1926	99.7	88.3
1927	89.1	85.3
1928	94.9	99.2
1929	100.0	100.0
1930	93.3	98.4
1931	63.0	73.9
1932	42.7	50.6
1933	51.6	56.5
1934	57.0	63.5
1935	58.8	69.7

[1] Preliminary report on *Productivity in the Fertilizer Industry* (National Research Project of the Works Progress Administration). Based upon employment data from census and Bureau of Labor Statistics and hours data from National Industrial Conference Board, Census, and Bureau of Labor Statistics.

[2] Loc. cit., based upon Census production data interpolated by National Fertilizer Association consumption data.

The formula.—The following formula was derived from the data:

$$\underset{(1929=100)}{\text{Calculated man-hours}} = (0.4901 + 0.1845\,(0.8806)^{\text{year}-1926})\ \underset{(1929=100)}{(\text{production})}^{1.098}$$

The average residual for the years of the period covered, 1920–32, is 3.9 percent, with the maximum of −10.0 percent in 1924.

The average residual for the years of the extrapolated period, 1933–35, is 5.9 percent, with the maximum of 8.9 percent occurring in 1933.

The amount of variation explained is 95 percent.

Summary No. 135b
Fertilizer—Consumption

Method used.—The consumption of fertilizer is related to the real cash crop income of the previous year, the ratio of prices received to prices paid in the current year, and a time trend. An exponential relationship was fitted to the data for the years 1924–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Fertilizer consumption [1] (millions tons)	Real cash crop income previous year [2] (1929=100)	Ratio of prices received to prices paid by farmers [3] (percent)
1924	68.25	105.5	94
1925	73.33	109.3	99
1926	73.28	105.9	94
1927	68.43	97.0	91
1928	79.85	102.4	96
1929	79.74	100.0	95
1930	81.63	101.9	87
1931	63.06	80.2	70
1932	43.36	60.6	61
1933	48.71	54.0	64
1934	55.48	68.2	74
1935	62.21	72.0	86

[1] National Fertilizer Association, 616 Investment Bldg., Washington, D. C., *Fertilizer Consumption in the United States.*

[2] Cash crop income as given by the Survey of Current Business deflated by prices paid by farmers as given by the Bureau of Agricultural Economics and Standard Statistics, converted to a 1929 base.

[3] Standard Trade and Securities, vol. 3, Statistical Section, p. D–23, June 5, 1936.

The formula.—The following formula was obtained from the data for the period 1924–32:

$$\underset{(\text{Ten million tons})}{\text{Calculated consumption}} = 0.01555\,(1.0471)^{\text{year}-1928}\ \underset{(1929=100)}{(\text{cash crop income previous year})}^{1.2843} \times (\text{ratio prices received to prices paid})^{0.189}$$

The average residual for the years 1924–32 is 1.5 percent, with the maximum of 2.4 percent occurring in 1928.

The average residual for the extrapolated years, 1933–35, is 11.0 percent with the maximum of 21.8 percent occurring in 1933.

The amount of variation explained is 98 percent.

Summary No. 136a
Coke—Manpower

Method used.—Man-hours in the coke-producing industry was related to coal consumed in the manufacture of coke by an exponential formula for the period 1921–32: Coke used for domestic purposes and coke used for industrial purposes were analyzed separately [1] but were added together and a relation between toal coke consumed and coal consumed in the manufacture of coke was derived.[2]

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (millions)	Production, coal consumed [2] (million tons)
1921	40.7	37.19
1922	52.6	54.34
1923	66.6	84.36
1924	51.9	64.98
1925	61.0	74.53
1926	61.6	82.87
1927	58.2	74.45
1928	54.1	77.18
1929	63.7	86.79
1930	56.0	69.81
1931	44.6	48.61
1932	33.2	31.92
1933	37.2	40.14
1934	42.9	45.98
1935	40.9	50.51

[1] *Coke Oven Accidents in the United States* (Bureau of Mines), 1934.

[2] *Minerals Yearbook* and *Mineral Resources of the United States* (Bureau of Mines). Production is measured by the consumption of coal in the process.

The formula.—The following formula was obtained from the data for the years 1921–32:

$$\text{Calculated man-hours per week} = 4{,}571{,}000\,(0.9900)^{\text{year}-1929}\ \underset{(\text{Million tons})}{(\text{coal consumption})}^{0.5873}$$

The average residual for the years 1921–32 is 2.9 percent, with the maximum of −8.0 percent occurring in 1928.

The average residual for the years of the extrapolated period, 1933–35, is 3.9 percent with the maximum of 5.4 percent occurring in 1934.

The amount of variation explained is 96 percent.

Summary No. 136b
Coke—Consumption (Industrial)

Method used.—Coke consumption was divided into two components—coke consumed for industrial uses and that consumed for domestic uses. The factors which were related to the consumption of coke for industrial purposes were the production of pig iron and a time trend.

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[1] See summary No. 136b.

[2] $\underset{(\text{Millions of tons})}{\text{Calculated coal consumed}} = -2.2 + 1.502\ \underset{(\text{Millions of net tons})}{(\text{coke consumed for all purposes})}$.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Coke consumption [1] (millions of tons)	Pig iron production [2] (millions of tons)
1919	44.7	31.0
1920	48.3	36.9
1921	22.6	16.7
1922	36.1	27.2
1923	53.7	40.4
1924	41.2	31.4
1925	47.6	36.7
1926	51.0	39.8
1927	45.7	36.6
1928	46.4	38.2
1929	52.0	42.6
1930	38.7	31.8
1931	23.8	18.4
1932	12.9	8.8
1933	17.7	13.3
1934	20.6	16.1
1935	26.3	21.4

[1] Data on coke consumption for 1922 35 are from the *Minerals Yearbook* of the Bureau of Mines and include furnace coke, foundry and other industrial coke, and coke used by producer; screenings and breeze are excluded. For the years 1919–22 an estimate was made deducting an estimate of "domestic coke sold" from the total. This estimate in turn was made by deducting an estimate for "other industrial coke" from "domestic and other coke sold." For 1919, breeze and screenings were also deducted. Data were taken from *Mineral Resources* (Bureau of Mines).

[2] Data on pig iron production are taken from the Iron Age—given in Standard Trade and Securities, Statistics Section, p. G-5.

The formula.—The following formula was obtained from the data for the years of the period 1919–32:

$$\underset{\text{(Millions of net tons)}}{\text{Calculated coke used for industrial purposes}} =$$

$$1.860\ \underset{\text{(Millions of gross tons)}}{(\text{pig iron produced})^{0.893851}}\ (0.9922)^{\text{year}-1926}$$

The average residual for the years of the period covered, 1919–32, is 2.4 percent, with the maximum of 5.8 percent occurring in 1921.

The average residual for the years of the extrapolated period, 1933–35, is 1.3 percent with the maximum of 1.9 percent occurring in 1935.

The amount of variation explained is 99 percent.

Summary No. 136c
Coke—Consumption (Domestic)

Method used.—The coke consumed for domestic uses was related to the ratio of the price of coke to the retail price of bituminous coal and time. In this case the linear formula appeared to be more satisfactory than the usual exponential formula.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Coke consumed for domestic purposes (millions of net tons) [1]	Price of coke deflated by price of coal (1923–25=100) [2]
1923	2.73	108.7
1924	2.95	95.8
1925	4.48	95.5
1926	5.44	99.9
1927	4.81	92.8
1928	6.33	87.5
1929	7.51	88.8
1930	8.03	85.1
1931	8.50	86.0
1932	9.63	85.1
1933	10.49	83.3
1934	10.52	87.7
1935	9.43	88.5

[1] *Minerals Yearbook* and *Mineral Resources of the United States*, Bureau of Mines.

[2] Source of coke price: *Minerals Yearbook* and *Mineral Resources of the United States* (Bureau of Mines) Wholesale price of domestic coke in dollars per net ton. Includes beehive and byproduct coke. Source of coal prices: *Survey of Current Business*. Retail price of bituminous coal in dollars per net ton, based on 38 cities. These 2 series were expressed as a ratio and put on a 1923-25 base.

The formula.—The following formula was derived from the data for the years of the period 1923–32:

$$\underset{\text{(Millions net tons)}}{\text{Calculated coke consumed for domestic purposes}} =$$

$$25.09 - 0.2233\ \underset{(1923\text{-}25=100)}{(\text{price of coke deflated by price of coal})} +$$

$$0.3600\ (\text{year} - 1923)$$

The early years fitted very badly. This is not due to a poorly fitting curve as such but the large percent residuals are due to the very small amount of coke consumed for domestic purposes in the early twenties.

The average residual for the fitted period is 74.3 percent and the largest 2 residuals are −271.6 percent and 237.1 percent for 1929 and 1923, respectively. If these first 2 years are dropped the average residual, 1925–32, is 10.8 percent, with the largest residuals 40.9 percent and −17.1 percent for 1926 and 1927, respectively.

The average residual for the extrapolated period, 1933–35, is 5.8 percent, with the maximum of 11.2 percent occurring in 1934.

The amount of variation explained is 74 percent.

Summary No. 137a
Iron and Steel—Manpower

Method used.—Man-hours was related to production and a time trend for the period 1923–32.

The data.—The data used in the analysis are presented in the following table:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Production [2] (1923-25=100)
1923	24.5	105
1924	20.2	89
1925	21.4	106
1926	22.3	113
1927	20.7	104
1928	21.1	119
1929	23.0	130
1930	17.9	94
1931	12.1	66
1932	6.4	31
1933	9.8	53
1934	10.2	60
1935	12.8	79

[1] Computed by mutiplying employment by average hours per week. Employment data from *Census of Manufactures* in odd years, interpolated by Bureau of Labor Statistics index of employment in even years. Average hours per week data from National Industrial Conference Board, *Wages, Hours and Employment in the United States, 1914–36* pp. 112–115.

[2] Federal Reserve Board index of iron and steel production.

The formula.—The following formula was obtained using the data for the years of the period 1923–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours per week}} =$$

$$0.4777\ (0.9681)^{\text{year}-1928}\ \underset{(1923\text{-}25=100)}{(\text{production})^{0.80283}}$$

The average residual for the years of the period covered, 1923–32, is 2.8 percent, with the maximum of −5.0 percent occurring in 1928.

The average residual for the years of the extrapolated period, 1933 35, is 1.2 percent, with the maximum of −2.9 percent occurring in 1934.

The amount of variation explained is 98.5 percent.

Summary No. 137b
Iron and Steel—Consumption

Method used.—The factors which were related to iron and steel consumption are industrial activity and a time trend. The Federal Reserve Board's index of industrial production was used to represent industrial activity. It is recognized that in this index iron and steel production forms a major component. But since, for the purpose of this study, only the statistical relationship and not a causal relationship is desired, there is no spuriousness involved in the correlation from this point of view. The exponential formula was replaced by the linear formula because the latter gave a slightly better fit and because the graphical analysis did not indicate curvilinearity.

The data.—The following data were used in the analysis:

Consumption and related factors

Year	Iron and steel consumption [1] (millions gross tons)	Industrial production [2] (1923-25=100)
1919	29.3	83
1920	36.0	87
1921	16.7	67
1922	32.1	85
1923	41.5	101
1924	35.1	95
1925	42.4	104
1926	45.1	108
1927	41.2	106
1928	47.0	111
1929	51.3	119
1930	37.3	96
1931	24.1	81
1932	12.6	64
1933	21.4	76
1934	23.7	79
1935	31.7	90
1936	44.2	105

[1] This is computed by converting the Federal Reserve Board index into the actual quantities of iron and steel produced by applying the factor 40.896 (000's) gross tons (the base figure for 1923-25). The production is then adjusted by exports and imports of iron and steel as reported in the *Annual Statistical Report of the American Iron and Steel Institute*. Scrap is excluded from exports and imports. The result is the amount of iron and steel available for consumption in the domestic market. No adjustment for changes in stocks was made.

[2] Federal Reserve Board.

The formula.—The following formula was derived from the data for the years of the period 1923-32:

$$\underset{\text{(Millions gross tons)}}{\text{Iron and steel consumption}} = 0.72148\ \underset{(1923\text{-}25=100)}{\text{(index industrial production)}} - 33.31$$

The average residual for the period 1923-32 is 2.5 percent, and the maximum residual of 4.8 percent occurring in 1923.

Iron and steel consumption was also calculated for the 4 years 1933-36. The average residual for these 4 years is 1.2 percent, the maximum residual of 4.2 percent occurring in 1936. Considering that iron and steel consumption fluctuates violently throughout the period, these extrapolated values seem to be reasonably close.

The amount of variation explained is 98 percent.

Summary No. 138a
Nonferrous Metals Other Than Copper (Smelting and Refining)—Manpower

Method used.—Employment was related directly to the index of production of the products in this segment. No time factor was utilized.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment [1] (thousands)	Production [2] (1929=100)
1921	12.7	40
1922	16.5	55
1923	20.9	74
1924	21.3	79
1925	21.6	88
1926	21.0	93
1927	20.2	94
1928	18.0	98
1929	21.5	100
1930	18.2	85
1931	13.3	61
1932	11.1	42
1933	12.6	49
1934	15.5	54
1935	16.8	64
1936	17.8	78

[1] Odd years 1921-35 *Census of Manufactures* (nonferrous metals less copper); years 1924, 1932, 1934, and 1936, interpolated from Bureau of Labor Statistics index of employment. Years 1922, 1926, 1928, and 1930, interpolated utilizing employment series given by Bureau of Mines, *Accidents in Metallurgical Plants*, and adjusted by man-days series in *Nonferrous Metals Plants, Excluding Copper*, published by Bureua of Mines.

[2] *Minerals Yearbook* (Bureau of Mines). Index based on production of lead, zinc, tin, and nickel (primary and secondary) weighted by 1929 values.

The formula.—The following formula was derived from the data for the years 1921-32:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 33.0 - 196.81\ \underset{(1929=100)}{\text{(production)}}^{-0.5987}$$

The average residual for the period 1921-32 is 9.6 percent, with the maximum of −17.9 percent occurring in 1931.

The average residual for the extrapolated period 1933-36 is 4.3 percent, with the maximum of −8.7 percent occurring in 1933.

The amount of variation explained is 73 percent.

Summary No. 138b
Lead—Consumption

Method used.—The factors which were related to consumption are: Consumer income, Federal Reserve Board index of industrial production, and time. The relation was expressed by an exponential function which was subsequently modified. The years covered are 1921-32.

The data.—The following table gives the data used in the correlation analysis:

Consumption and related factors

Year	Consumption [1] (thousands short tons)	Consumer income [2] (billions of 1936 dollars)	Industrial production [2] (1923-25=100)
1921	521	42.3	67
1922	683	48.8	85
1923	768	54.8	101
1924	812	55.4	95
1925	856	57.0	104
1926	901	58.3	108
1927	841	58.9	106
1928	931	62.2	111
1929	972	65.3	119
1930	769	60.4	96
1931	568	54.6	81
1932	416	46.7	64
1933	453	48.2	76
1934	491	54.0	79
1935	543	56.9	90

[1] *Mineral Resources* and *Minerals Yearbook* (Bureau of Mines) for the respective years. Data compiled by American Bureau of Metal Statistics represent consumption of primary and secondary lead.

[2] See table 1 of this Appendix.

The formula.—The following formula was derived by correlation analysis for the years of the period 1921–32:

$$\underset{\text{(Thousands net tons)}}{\text{Calculated consumption}} = [0.4039\,(1.006-0.0274\,(\text{year}-1926)]\ \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income}))^{1.1525}} \times \underset{(1923\text{-}25=100)}{(\text{production})^{0.6206}}$$

The average residual for the years of the period covered, 1921–32, is 2.2 percent, with the maximum of −9.3 percent occurring in 1923.

The average residual for the years of the extrapolated period, 1933–35, is 3.5 percent, with the maximum of −4.9 percent occurring in 1935.

The amount of variation explained is 96.5 percent.

Summary No. 138c
Zinc—Consumption

Method used.—The factors which were related to zinc consumption are the Federal Reserve Board index of industrial activity and a time trend. An exponential relationship was fitted to the data for 1919–32.

The data.—The following table shows the data used in the analysis:

Consumption and related factors

Year	Zinc consumption [1] (thousand tons)	Industrial production [2] (1923–5=100)
1919	402	83
1920	424	87
1921	263	67
1922	440	85
1923	515	101
1924	512	95
1925	579	104
1926	622	108
1927	583	106
1928	626	111
1929	634	119
1930	451	96
1931	370	81
1932	259	64
1933	350	76
1934	360	79
1935	461	90

[1] Data from the American Bureau of Metal Statistics as reproduced in *Mineral Resources* and *Minerals Yearbook* of the Bureau of Mines.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1919–32:

$$\underset{\text{(Tons)}}{\text{Calculated consumption}} = 342.8\,(0.99574)^{\text{year}-1926}\ \underset{(1923\text{-}25=100)}{(\text{industrial production})^{1.5923}}$$

The average residual for the years covered, 1919–32, is 4 percent, with a maximum of −7.3 percent occurring in 1929.

The average residual for the years extrapolated, 1933–35, is 5.9 percent, with a maximum of 8.0 percent occurring in 1935.

The amount of variation explained is 96 percent.

Summary No. 138d
Nonferrous Metals Other Than Copper, Lead, and Zinc—Consumption

Methods used.—The consumption of the products in this segment was related to the Federal Reserve Board index of production and a time trend utilizing a linear relationship with an exponential time factor.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (1926=100)	Industrial production [2] (1923–25=100
1919	64.3	83
1920	74.5	87
1921	32.1	67
1922	56.0	85
1923	83.7	101
1924	86.4	95
1925	96.9	104
1926	100.0	108
1927	101.4	106
1928	141.0	111
1929	136.9	119
1930	116.7	96
1931	93.1	81
1932	55.8	64
1933	80.4	76
1934	72.4	79
1935	99.2	90

[1] *Minerals Yearbook.* Aggregate index of consumption of aluminum, tin, and nickel, weighted by 1929 unit values.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years of the period 1919–32:

$$\underset{(1926=100)}{\text{Calculated consumption}} = [1.6529\,\underset{(1923\text{-}25=100)}{(\text{industrial production})} - 67.8]\,(1.04)^{\text{year}-1926}$$

The average residual for the years 1919–32 is 11.2 percent, with the maximum of 23.8 percent in 1920.

The average residual for the extrapolated period, 1933–35, is 11.8 percent, with the maximum of −15.5 percent occurring in 1934.

The amount of variation explained is 89 percent.

Summary No. 138.1a
Copper Smelting and Refining—Manpower

Method used.—Manpower was related to copper production and a time trend. An additive relationship was derived based on the data for the period 1921–32. The additive form of the function appeared to give a somewhat better fit than the multiplicative form.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Wage earners [1] (thousands)	Production of refined copper [2] (thousands of tons)
1921	8.3	639
1922	11.2	844
1923	16.8	1,294
1924	16.2	1,402
1925	15.6	1,406
1926	15.5	1,516
1927	13.9	1,527
1928	14.5	1,644
1929	14.5	1,841
1930	12.7	1,425
1931	8.6	1,017
1932	6.0	525
1933	5.6	634
1934	8.4	759
1935	10.4	954
1936	11.9	1,210

[1] *Census of Manufactures* data in odd years, interpolated in 1924, 1932, 1934, and 1936 by Bureau of Labor Statistics employment index, and in 1922, 1926, 1928, and 1930 by a series of employment in mills and smelters in copper metallurgical plants (from *Accidents at Metallurgical Works in the United States* (Bureau of Mines).

[2] Bureau of Mines, *Mineral Resources of the United States* and *Minerals Yearbook.*

The formula.—The following formula was obtained from the data for the years of the period 1921–32:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} =$$

$$19.1415 - 159{,}866\ \underset{\text{(Thousands of tons)}}{(\text{production})}^{-1.52768} - 0.308\ (\text{year} - 1919)$$

The average residual for the period 1921–32 is 12.1 percent, with the maximum of 50.0 percent occurring in 1932.

The average residual for the extrapolated period, 1933–36, is 8.4 percent, with the maximum of −13.8 percent occurring in 1933.

The amount of variation explained is 97 percent.

Summary No. 138.1b
Copper—Consumption

Method used.—The consumption of refined copper was related to the Federal Reserve Board index of industrial production, the consumer income, and time, by an exponential formula with a linear multiplicative time trend, for the years 1919–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption of refined copper [1] (thousands of net tons)	Industrial production [2] (1923–25=100)	Consumer [2] income (billions of 1936 dollars)
1919	457.2	83	46.6
1920	526.9	87	47.0
1921	365.5	67	42.3
1922	448.3	85	48.8
1923	650.2	101	54.8
1924	677.4	95	55.4
1925	700.5	104	57.0
1926	785.1	108	58.3
1927	711.5	106	58.9
1928	804.3	111	62.2
1929	889.3	119	65.3
1930	632.5	96	60.4
1931	451.6	81	54.6
1932	259.6	64	46.7
1933	339.4	76	48.2
1934	322.6	79	54.0
1935	425.5	90	56.9

[1] Bureau of Mines, reported in *Standard Statistics;* annual totals for United States only. Does not include secondary copper.

[2] See table I of this Appendix.

The formula.—The formula derived from the data to express the relationship for the years 1919–32 was:

$$\underset{\text{(Thousands of net tons)}}{\text{Calculated copper consumption}} =$$

$$0.008138\ \underset{(1923\text{-}1925=100)}{(\text{industrial production})}^{1.0014}\ \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})}^{1.6565} \times$$

$$[1.008 - 0.0269\ (\text{year} - 1926)]$$

The average residual for the period 1919–32 is 3.4 percent, with the maximum of −7.6 percent occurring in 1922.

The average residual for the extrapolated period 1933–35 is 10.0 percent, with a maximum of −15.0 percent occurring in 1934.

The amount of variation explained is 96.5 percent.

Summary No. 139a
Iron and Steel Products—Manpower (Excluding Machinery)

Method used.—This segment includes all iron and steel products except the industry classified by the Census as iron and steel, and machinery. The output was measured in terms of deflated value. A man-hours series was related to output and a time trend.

The data.—The following table presents the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Deflated value of output [2] (millions of 1926 dollars)
1920	23.59	2,610
1921	13.29	1,470
1922	18.95	2,230
1923	23.13	2,570
1924	20.18	2,250
1925	22.44	2,700
1926	23.18	2,920
1927	21.41	3,810
1928	21.37	3,050
1929	22.79	3,080
1930	16.65	2,500
1931	11.32	1,860
1932	7.36	1,080
1933	8.79	1,400
1934	11.13	1,760
1935	13.38	2,340
1936	18.64	3,120

[1] Computed by multiplying employment by average hours per week. Average hours per week were obtained from the National Industrial Conference Board data on average hours in foundries, machines and machine tools, and hardware and small parts industries. A simple average was taken weighting each series equally. The number of wage earners for all years except 1920 and 1922 was obtained by deducting the wage earners in the iron and steel industry from the wage earners in the total iron and steel group. The wage earners in the total iron and steel group and in the iron and steel industry were taken from the *Census of Manufactures* for odd years, and even years were interpolated with the employment indexes of the Bureau of Labor Statistics. 1920 and 1922 were obtained by using the geometric means of ratios between total iron and steel group wage earners and other iron and steel wage earners for prior and subsequent years.

[2] A price index of iron and steel products was obtained by computing an average of the Bureau of Labor Statistics price indexes for planes, barrels, bolts, noncutting tools, nails, cast pipe, other pipe, saws, and wire, weighted according to the weights given by the Bureau of Labor Statistics. This index was used to deflate the value of products obtained from the *Census of Manufactures* for odd years. Even years were interpolated by using the production of steel ingots, obtained from the American Iron and Steel Institute, *The Iron Age*, Jan. 3, 1935, p. 275, and the Annual Statistical Report of the American Iron and Steel Institute, corrected to include electric and crucible steel.

The formula.—The following formula was derived from the data for the years of the period 1920–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours/week}} =$$

$$0.008517\ (0.9683)^{\text{year}-1926}\ \underset{\text{(Millions 1926 dollars)}}{(\text{deflated value of output})}^{0.9889}$$

The average residual for the years 1920–32 is 4.2 percent, with the maximum of 7.6 percent occurring in 1924.

The average residual for the extrapolated years, 1933–36, is 3.1 percent, with the maximum of 5.8 percent occurring in 1936.

The amount of variation explained is 97.5 percent.

Summary No. 139b
Iron and Steel Products—Consumption

Method used.—The factors which were related to the consumption of iron and steel products are the Federal Reserve Board index of industrial production and a relative price index for the years 1919–32.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption[1] (ten millions, 1926 dollars)	Industrial production[2] (1923–25=100)	Relative price[3] (1926=100)
1919	184	83	83.2
1920	250	87	84.7
1921	140	67	108.1
1922	219	85	95.8
1923	252	101	103.3
1924	219	95	107.3
1925	263	104	98.3
1926	285	108	100.0
1927	274	106	100.9
1928	297	111	99.2
1929	300	119	102.1
1930	243	96	104.6
1931	182	81	115.2
1932	106	64	124.7
1933	138	76	119.6
1934	173	79	113.1
1935	231	90	104.5
1936	308	105	102.5

[1] Data on consumption are obtained by deducting deflated net export values from the deflated value of production as obtained in the man-hour analysis, summary No. 139a. Imports and exports are taken from the *Statistical Abstract of the United States*, Department of Commerce.

[2] Federal Reserve. See table I of this Appendix.

[3] See summary No. 139a: Iron and steel products—Manpower.

The formula.—The formula obtained from the data for the period 1919–32 is as follows:

$$\underset{\text{(Ten millions of 1926 dollars)}}{\text{Calculated consumption}} =$$

$$2.65\ (0.9976)^{\text{year}-1926}\ \underset{(1923\text{–}25=100)}{(\text{industrial production})}^{1.4795} \times$$

$$\underset{(1926=100)}{(\text{relative price})}^{-0.49065}$$

The average residual for the years of the period 1919–32, is 5.1 percent, with the maximum of −13.6 percent occurring in 1919.

The average residual for the extrapolated period, 1933–35, is 11.0 percent, with the maximum of 18.0 percent occurring in 1936.

The amount of variation explained is 94 percent.

Summary No. 140a
Nonferrous Metal Products—Manpower

Method used.—Man-hours were related directly to the Federal Reserve Board index of industrial production over the interval 1925–32 from which the relationship was derived.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours[1] (millions per week)	Industrial production[2] (1923–25=100)
1925	11.50	104
1926	11.76	108
1927	11.45	106
1928	12.20	111
1929	13.40	119
1930	10.28	96
1931	7.48	81
1932	5.29	64
1933	6.23	76
1934	7.57	79
1935	9.21	90

[1] Wage earners for odd years (*Census of Manufactures*); for even years the Bureau of Labor Statistics employment series for seven nonferrous metals products was used as an interpolating medium. Average hours per week for 1932–35 (Bureau of Labor Statistics); for the years 1925–32 the average hours per week for 25 industries (National Industrial Conference Board) spliced to the Bureau of Labor Statistics series in 1932 was utilized.

[2] See table I of the Appendix.

The formula.—The following formula was derived from the data for the years 1925–32:

$$\underset{\text{(Millions per week)}}{\text{Calculated man-hours}} =$$

$$0.009448\ \underset{(1923\text{–}25=100)}{(\text{industrial production})}^{1.5235}$$

The average residual for the years 1925–32 is 1.7 percent, with a maximum of 3.9 percent occurring in 1930.

The average residual for the extrapolated period, 1933–35, is 5.4 percent, with a maximum of −10.1 percent occurring in 1933.

The amount of variation explained is 99 percent.

Summary No. 141a
Automobiles—Manpower

Method used.—An index of man-hours was related to production of all automobiles and a time trend.

The data.—The following table gives the data that was used in the analysis:

Manpower and related factors

Year	Man-hours/week[1] (1923–25=100)	Aubomobile production[2] (1923–25=100)
1920	86.8	58
1921	50.5	41
1922	71.2	66
1923	102.5	102
1924	90.6	91
1925	106.9	107
1926	106.8	108
1927	90.8	86
1928	110.1	110
1929	111.2	135
1930	68.1	85
1931	56.0	60
1932	39.4	35
1933	46.6	48
1934	67.7	69
1935	78.2	99

[1] Wage earners are based on *Census of Manufactures* data for the census years and for the noncensus years the Bureau of Labor Statistics employment indexes were used for interpolation. Average hours per week are from the National Industrial Conference Board, *Hours and Wages in the United States, 1914–36*. Man-hours are the product of employment by average hours per week put on 1923–25 base.

[2] Federal Reserve Board index of automobile production.

The formula.—The following formula was obtained from the data for the years of the period 1920–32:

$$\underset{(1923\text{–}25=100)}{\text{Calculated man-hours per week}} =$$

$$2.765\ (0.9743)^{\text{year}-1926}\ \underset{(1923\text{–}25=100)}{(\text{automobile production})}^{0.7738}$$

The average residual for the years of the period 1920–32 is 6.6 percent; the maximum of 16.0 percent occurring in 1920. The average residual for the extrapolated years, 1933–35, is 5.8 percent, with the maximum of 14.0 percent occurring in 1934.

The percent of variation explained is 94 percent.

Summary No. 141b
Retail Sales of Passenger Cars

Method used.—The factors which were related to retail sales of passenger cars are (1) consumer income, divided into two parts—consumer income of wage earners and all other consumer income; (2) the number of cars 7 years old or more in use at the beginning of the year; and (3) a time trend. The consumer income was divided into two parts because the two groups of income recipients react differently in their demand for cars with a change in income. An estimate of the number of cars which were at least 7 years of age at the beginning of the year was obtained by applying a constant 7-year life table to the annual sales of cars.

An improvement on this can be made by assuming a changing life of car through time, but no readily available measure of this factor was obtainable.

The data.—The following table gives the data used in the analysis. These data are fairly reliable except as noted above regarding the improvement which can be made in the series of number of cars which were at least 7 years of age.

Retail sales of passenger cars and related factors

Year	Consumer income of wage earners [1] (billions of 1936 dollars)	Consumer income of other than wage earners [2] (billions of 1936 dollars)	Cars at least 7 years of age [3] (thousands)	Retail sales of passenger cars [4] (thousands)
1919	11.9	34.7	280	1,540
1920	13.0	34.1	480	1,640
1921	9.8	32.4	950	1,460
1922	10.9	37.9	1,350	2,080
1923	13.6	41.2	1,930	3,260
1924	12.7	42.7	2,310	3,120
1925	12.7	44.3	3,040	3,220
1926	13.3	45.0	2,800	3,330
1927	13.0	45.8	3,020	2,760
1928	13.2	49.0	3,070	3,250
1929	13.9	51.4	3,130	3,850
1930	11.7	48.7	3,080	2,600
1931	9.4	45.3	3,830	1,850
1932	6.9	39.8	4,460	1,070
1933	7.5	40.7	5,790	1,500
1934	9.2	44.8	7,820	1,910
1935	10.0	46.9	8,820	2,850
1936	11.4	52.5	9,800	3,480

[1] Wages in mining, manufacturing, transportation, and construction. From 1929-36 estimates by the Department of Commerce, National Income in 1936, *Survey of Current Business*, June 1936; from 1919-29 based on the National Bureau of Economic Research recent revision of their income series. This was spliced to the 1929 figure of the Department of Commerce. The value data were deflated by the Bureau of Labor Statistics cost of living index 1936=100.

[2] Total consumer income less consumer income of wage earners.

[3] Computed by subtracting the number of cars 6 years of age and under from the total cars in use at the beginning of the year. The total cars in use are calculated by subtracting the new car registrations during any year from the registrations at end of that year. Number of cars 6 years of age and under are computed by applying a 7-year survival table (0 year 0.98, 1 year 0.94, 2 years 0.88, 3 years 0.80, 4 years 0.69, 5 years 0.56, 6 years 0.42) to retail sales.

[4] From 1929-36 given by the Automobile Manufacturers Association; from 1919-29 computed from factory sales adjusted by exports and imports, given in *Automobile Facts and Figures*, Automobile Manufacturers Association, 1936 and previous years; for these years sales to Government were excluded and a correction for an estimate in changes in dealers' stocks was also made.

The formula representing the relationship.—In the preliminary graphical analysis it was observed that the data for the years 1919, 1920, and 1927 deviated considerably from the curves of relationships. The income data for the post-war years 1919–20 are not very reliable. Furthermore, these 2 years are abnormal in many respects. Ford shut down his plant in 1927 and the introduction of several new 1928 cars was announced in 1927. For these reasons the data for these 3 years were omitted in the numerical analysis. The formula which was obtained to calculate car sales is as follows:

$$\underset{\text{(thousands)}}{\text{Passenger car sales}}=0.4123\ (0.9561)^{\text{year}-1927}\times$$

$$\left[19+1.006\underset{\text{(Billions of 1936 dollars)}}{\begin{pmatrix}\text{consumer income}\\ \text{of wage earners}\end{pmatrix}}^{2.1795}\right]^{0.6899}\underset{\text{(Billions of 1936 dollars)}}{\begin{pmatrix}\text{other consumer}\\ \text{income}\end{pmatrix}}^{1.2574}\times$$

$$[0.9144+0.0001184\ \underset{\text{(thousands)}}{\text{(number of cars at least 7 years of age)}}]$$

This formula was derived from the data for the years of the period 1921–32 (omitting 1927). Although it appears that there are nine constants in this equation, actually only four were determined by the least squares method. The expressions in the brackets were approximations determined by the graphical analysis.

The average percent deviation of the calculated car sales from the actual car sales for the period 1921–32 is 1.5 percent, the maximum percent deviation being −4.5 percent in 1928. The average percent deviation of the extrapolated car sales from the actual car sales for the 4 years 1933–36 is 7.4 percent. The maximum deviation 14.0 percent occurs in 1935.

Summary No. 143a
Transportation Equipment Other Than Automobiles—Manpower

Method used.—Man-hours was related directly to the consumer income and a time trend. An exponential relationship was fitted to the data for the years of the period 1924–32, omitting 1928, since the data for this year appears to deviate tremendously from the time relationship.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (millions per week)	Consumer income [2] (billions of 1936 dollars)
1924	6.75	55.4
1925	6.25	57.0
1926	6.37	58.3
1927	5.86	58.9
1928	4.99	62.2
1929	6.33	65.3
1930	5.54	60.4
1931	3.56	54.6
1932	2.45	46.7
1933	2.12	48.2
1934	2.96	54.0
1935	3.21	56.9
1936	4.21	63.9

[1] Man-hours: Wage earners for the entire transportation section was obtained from the Census for odd years, the even years being interpolated by the Bureau of Labor Statistics employment index. Automobile wage earners were deducted to obtain the wage earners in this segment. Average hours per week for 1932–36 was obtained from the Bureau of Labor Statistics; for 1919, 1921, 1923, and 1929, census prevailing hours less 5 percent was used; other years were interpolated using the average hours in 25 manufacturing industries as reported by the National Industrial Conference Board. Man-hours is the product of the average hours so obtained and the number of wage earners.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1924–32, excluding 1928.

$$\underset{\text{(Millions)}}{\text{Calculated man-hours per week}}=$$

$$0.09838\ (0.9281)^{\text{year}-1928}\ \underset{\text{(Ten billion 1936 dollars)}}{\text{(consumer income)}}^{2.2755}$$

The average residual for the years covered by the analysis, 1924–27 and 1929–32, is 3.4 percent, with a maximum of 9.3 percent occurring in 1930.

The average residual for the extrapolated years, 1933–36, is 8.4 percent, with a maximum of 13.8 percent occurring in 1936.

The amount of variation explained is 97 percent.

Summary No. 144a
Electrical Machinery—Manpower

Method used.—A man-hour series was related directly to consumer income and a time trend. An exponential form of relationship was used in which the time factor was modified into the form of an exponential with an additive constant.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Consumer income [2] (billions of 1936 dollars)
1920	8.28	47.0
1921	6.96	42.3
1922	9.32	48.8
1923	10.95	54.8
1924	9.93	55.4
1925	10.25	57.0
1926	11.06	58.3
1927	9.54	58.9
1928	10.39	62.2
1929	13.41	65.3
1930	10.19	60.4
1931	6.41	54.6
1932	4.07	46.7
1933	4.33	48.2
1934	5.36	54.0
1935	6.61	56.9
1936	8.11	63.9

[1] Wage earners for odd years based on *Census of Manufactures* and for the even years interpolated by the Bureau of Labor Statistics' employment indexes. The National Industrial Conference Board's hours per week were used from 1930 to 1931 and these were spliced to the Bureau of Labor Statistics average hours per week obtainable from 1932 to 1936. The man-hours per week are obtained by the product of wage earners by average hours per week.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years of the period 1920–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours per week}} = 0.0003375\ [0.4395+0.3805\ (0.8952)^{\text{year}-1929}] \times \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})}^{2.5492}$$

The average residual for the years of the period 1920–32 is 6.6 percent, with the maximum of 14.4 percent occurring in 1928.

The average residual for the extrapolated years, 1933–36, is 4.4 percent, with the maximum of −7.3 percent occurring in 1934.

The percent of variation explained is 93 percent.

Summary No. 145a
Machinery (Excluding Electrical)—Manpower

Method used.—A man-hours series was related to deflated value of output and a time trend. The time trend was used in the form of an exponential with an additive term.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Deflated value of output [2] (millions of 1926 dollars)
1921	28.18	2,090
1922	26.75	2,239
1923	34.47	3,212
1924	28.68	2,978
1925	31.18	3,454
1926	33.94	3,585
1927	32.63	3,998
1928	37.63	4,410
1929	38.84	4,870
1930	28.33	3,721
1931	17.47	2,685
1932	10.56	1,514
1933	12.51	1,787
1934	17.34	2,144
1935	22.02	3,699

[1] Wage earners based on Census values interpolated by Bureau of Labor Statistics employment series. Average hours per week from National Industrial Conference Board. *Wages and Hours in the United States, 1914–36*, for foundries and machine shops 1920–31 and spliced to the Bureau of Labor Statistics average hours per week for the same industry. Man-hours is employment multiplied by average hours per week.

[2] Value of products is obtained from the *Census of Manufactures* for the census years and interpolated by a series represented by the gross income of corporations for metal products given by the annual *Statistics of Income* of the Bureau of Internal Revenue. The value is deflated by the Bureau of Labor Statistics price index of all commodities, excluding foods.

The formula.—The following formula was derived from the data for the years 1921–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours per week}} = 0.008112\ [0.46+0.40\ (0.9170)^{\text{year}-1930}] \times \underset{\text{(Millions of 1926 dollars)}}{(\text{deflated value of output})}^{1.0083}$$

The average residual for the years 1921–32 is 4.9 percent, with the maximum of 10.5 percent occurring in 1922.

The average residual for the extrapolated period, 1933–35, is 12.5 percent, with the maximum of 27.0 percent occurring in 1934. These high percentages are due to the low level of man-hours in this industry during recent years.

The amount of variation explained is 96 percent.

Summary No. 145b
Machinery (Excluding Electrical)—Consumption

Method used.—The consumption of machinery was expressed in terms of deflated value. It was related to consumer income and a time trend using a linear regression. The linear form was used since the graphical analysis indicated that a somewhat better fit would have been obtained than that given by the multiplicative form.

The data.—The following data were used in the analysis:

Consumption and related factors

Year	Deflated value of consumption [1] (millions of 1926 dollars)	Consumer income [2] (billions of 1936 dollars)
1921	980	42.3
1922	2,080	48.8
1923	3,020	54.8
1924	3,090	55.4
1925	2,850	57.0
1926	3,290	58.3
1927	3,670	58.9
1928	4,020	62.2
1929	4,430	65.3
1930	3,320	60.4
1931	2,430	54.6
1932	1,410	46.7
1933	1,680	48.2
1934	1,980	54.0
1935	3,490	56.9

[1] Value of products from *Census of Manufactures* for odd years. For noncensus years the values are obtained by using as an interpolating series the gross income of corporations of metal products manufacturing as given in the *Statistics of Income*, Bureau of Internal Revenue. The value series was then adjusted for the net exports of machinery, by the Department of Commerce and reported in the issues of the *Statistical Abstract of the United States*. The series was then deflated by the Bureau of Labor Statistics index of all commodity prices except foods. No adjustment was made for changes in stocks.

[2] See table I of this Appendix.

The formula.—The following formula was derived by least squares for the years of the period 1921–32:

$$\underset{\text{(Millions of 1926 dollars)}}{\text{Calculated deflated value of output}} = -5856.5\quad 27.657\ (\text{year}-1928) + 157.305\ \underset{\text{(Billions of 1936 dollars)}}{(\text{consumer income})}$$

The average residual for the years of the period, 1921–32, is 4.4 percent, with the maximum of 10.7 percent occurring in 1925. The average residual for the extrapolated period, 1933–35, is 15.3 percent, with the maximum of 20.3 percent occurring in 1935. These residuals are large because the level of consumption has been very low during recent years.

The amount of variation explained is 95 percent.

Summary No. 146a Miscellaneous Manufacturing Industries—Manpower

Method used.—Man-hours was related to the Federal Reserve Board index of industrial production and a time trend. An exponential relationship was fitted to the data for the years 1920–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours per week [1] (millions)	Industrial production [2] (1923-25=100)
1920	15.71	87
1921	11.69	67
1922	13.48	85
1923	14.91	101
1924	14.54	95
1925	14.85	104
1926	15.39	108
1927	15.26	106
1928	14.85	111
1929	15.55	119
1930	12.03	96
1931	9.13	81
1932	6.54	64
1933	7.53	76
1934	8.47	79
1935	9.26	90

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[1] Computed by multiplying employment by average hours per week. Employment data obtained by subtracting the sum of all the individual manufacturing segments from the total for all manufacturing industries (all employment series based upon *Census of Manufactures* data in odd years, interpolated by Bureau of Labor Statistics employment indexes in even years.) Average hours per week data are for 25 manufacturing industries as reported by National Industrial Conference Board.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the period years of the 1920–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours per week}} = 0.08308\ (0.9612)^{\text{year}-1926}\ \underset{(1923\text{-}25=100)}{(\text{industrial production})}^{1.1162}$$

The average residual for the years covered by the analysis, 1920–32, is 2.6 percent, with a maximum of −7.6 percent occurring in 1923.

The average residual for the extrapolated period, 1933–35, is 5.5 percent, with a maximum of 6.7 percent occurring in 1934.

The amount of variation explained is 97 percent.

MINING

Summary No. 201a
Crude Petroleum and Natural Gas—Manpower

Method used.—Crude petroleum and natural gas output is represented by the number of oil and gas wells drilled. Employment was related to the number of wells drilled by a graphic regression line for the years 1919–32. The time factor was not important. The linear form was used since the graphical analysis indicated no significant curvilinearity in the scatter.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Wage earners [1] (thousands)	Oil and gas wells drilled [2] (thousands)
1919	123.7	29.2
1920	146.2	33.9
1921	105.6	21.9
1922	128.1	24.7
1923	129.7	24.4
1924	117.1	21.9
1925	131.9	28.6
1926	160.3	29.3
1927	138.7	24.1
1928	108.0	22.3
1929	140.0	26.4
1930	118.6	21.2
1931	87.6	12.4
1932	76.4	15.0
1933	90.3	12.3
1934	112.8	18.2
1935	108.7	21.4
1936	105.8	25.9

[1] 1919–28, unpublished data of National Bureau of Economic Research adjusted to Department of Commerce data; 1929–36, data from Department of Commerce, Bureau of Foreign and Domestic Commerce.
[2] Source: American Petroleum Institute, *Statistical Bulletin*, Mar. 27, 1937.

The formula.— The following formula was obtained from the data for the period 1919–32:

$$\underset{\text{(Thousands)}}{\text{Calculated wage earners}} = 13 + 4.7\ \underset{\text{(Thousands)}}{\text{(number of wells drilled)}}$$

The average residual for the period fitted, 1919–32, is 7.2 percent, the maximum of −17.6 percent occurring in 1919.

The average residual for the extrapolated period, 1933–36, is 17.0 percent, with the maximum of 27.5 percent occurring in 1933.

The amount of variation explained is 70 percent.

Summary No. 201b
Crude Petroleum and Natural Gas—Output

Method used.—The number of oil and gas wells drilled was taken to roughly represent crude oil output, and was related to crude petroleum prices, industrial production, and time by an exponential formula using the method of least squares for the period 1919–32.

The data.—The following table gives the data used in the analysis:

Output and related factors

Year	Oil and gas wells drilled [1] (thousands)	Price of crude petroleum [2] (1926=100)	Industrial production [3] (1923-25=100)
1919	29.2	121.0	83
1920	33.9	180.7	87
1921	21.9	91.9	67
1922	24.7	95.3	85
1923	24.4	76.3	101
1924	21.9	77.0	95
1925	25.6	88.6	104
1926	29.3	100.0	108
1927	24.1	68.2	106
1928	22.3	63.9	111
1929	26.4	65.4	119
1930	21.2	59.0	96
1931	12.4	30.4	81
1932	15.0	43.0	64
1933	12.3	30.1	76
1934	18.2	49.9	79
1935	21.4	49.9	00
1936	25.9	55.5	105

[1] *Statistical Bulletin*, American Petroleum Institute, Mar. 27, 1937.
[2] Bureau of Labor Statistics; Kansas, Oklahoma: price at well.
[3] See table I of this Appendix.

The formula.—The following formula was derived from the data for the period 1919–32:

$$\underset{\text{(Thousands)}}{\text{Calculated oil and gas wells drilled}} =$$
$$0.2075\ \underset{(1926=100)}{\text{(price of crude petroleum)}}^{.5948} \times$$
$$\underset{(1923\text{-}25=100)}{\text{(industrial production)}}^{.4727} \times (1.008)^{\text{year}-1926}$$

The average residual for the period 1919–32 is 3.7 percent, with the maximum of 7.8 percent occurring in 1929.

The average residual for the extrapolated period 1933–36, is 8.9 percent, with the maximum of 17.2 percent occurring in 1936.

The amount of variation explained is 96 percent.

Summary No. 202a
Underground Man-Days in Bituminous Coal Mining

Method used.—Various combinations of factors were tried. Man-days per ton was expressed as a linear equation in terms of a time trend, average days worked, and tons per mine per year, but the results were unsatisfactory. The most satisfactory results were obtained by expressing man-days per ton as a linear function of a time trend and tons per mine per day (which reflects crudely the size of mine). The coefficients were determined from the data for the years of the period 1918–32. The amount of variation explained was 92 percent. However, the influence attributable to the size of mine factor was reflected mostly in the time trend factor since over this period these two factors are highly intercorrelated. In 1933 and 1934 a significant shift in size of mine and man-days per ton occurred and when the correlation was carried out for the years of the period 1918–34 the influence of size of mine was more definitely separated from that of time trend. Since over this period the variance explained was also 92 percent it is evident that only a shift in the slopes of size of mine and time trend took place. The results of the second analysis were therefore used.

The data.—The following table gives the data used in the analysis:

Underground man-days and related factors

Year	Actual underground man-days [1] (millions)	Underground production [2] (millions net tons)	Size of mine [3] (tons per day per mine)
1918	123. 6	570	279
1919	99. 2	459	265
1920	116. 6	555	287
1921	84. 5	411	347
1922	82. 7	408	317
1923	107. 4	551	347
1924	91. 0	470	374
1925	98. 8	503	373
1926	109. 8	556	373
1927	97. 8	499	387
1928	91. 5	481	382
1929	95. 0	515	401
1930	79. 8	448	422
1931	62. 0	363	420
1932	50. 5	290	384
1933	58. 9	315	349
1934	62. 1	339	322
1935	61. 1	349	328

[1] Bureau of Mines, *Minerals Yearbook* and *Minerals Resources of the United States* for the various years.

[2] *Ibid.:* Total production per day divided by number of mines of commercial size.

The formula.—The final formula which was obtained using the data for the years 1918–34 is as follows:

$$\underset{\text{(Millions)}}{\text{Calculated man-days}} = \underset{\text{(Millions of net tons)}}{(\text{production})}\,[0.2349-0.001726\,(\text{year}-1926)$$

$$-0.0001152\,(\text{tons per mine per day})]$$

The average residual for the years of the period covered, 1918–34, is 1.6 percent with a maximum of −4.0 percent in 1931.

The residual for the extrapolated year, 1935, is −3.3 percent.

The amount of variation explained is 92 percent.

Summary No. 202b

Bituminous Coal—Consumption

Method used.—The factors which were related to consumption of bituminous coal are (1) industrial production, (2) consumer income, (3) an index of the ratio of coal prices to fuel oil prices, (4) an index representing efficiency in the use of fuel, and (5) a time factor. The analysis was first worked out without introducing the index of efficiency in the relationship. However, it was desirable to cut down the effect of the time factor and in part to explain this effect by introducing the index of efficiency in the use of fuel as a separate factor. The equation was worked using the data from 1919 through 1932 and the constants were determined from an exponential form .

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Industrial production [1] (1923-25=100)	Consumer income [2] (billions of 1936 dollars)	Ratio of coal prices to fuel oil prices [3] (1926=100)	Index of efficiency [4] (1920=100)	Consumption of bituminous coal [5] (million net tons)
1919	83	46. 6	139 7	100. 7	482
1920	87	47 0	89. 9	100. 0	509
1921	67	42. 3	261. 2	92. 7	392
1922	85	48. 8	199. 7	89. 9	427
1923	101	54. 8	181 3	89. 3	519
1924	95	55. 4	143. 9	83. 7	484
1925	104	57. 0	116. 7	79. 7	499
1926	108	58. 3	100 0	76. 6	533
1927	106	58. 9	127. 9	74. 3	500
1928	111	62 2	161. 0	72 2	499
1929	119	65. 3	153. 2	70. 3	520
1930	96	60. 4	150 8	68. 7	455
1931	81	54. 6	236. 0	67. 0	372
1932	64	46. 7	193. 3	67. 1	307
1933	76	48. 2	180. 1	66. 3	322
1934	79	54. 0	149. 6	66. 5	347
1935	90	56. 9	149. 4	65. 8	360
1936	105	63. 9	E 145. 3	E 65. 2	417

The formula.—The formula obtained using the data for the years of the period 1919 through 1932 is:

$$\underset{\text{(Millions of net tons)}}{\text{Calculated consumption}} =$$

$$9.076\,(0.9745)^{\text{year}-1926}\,(1.00094)^{\text{efficiency index (1920=100)}} \times$$

$$\underset{(1923\text{–}25=100)}{(\text{industrial production})^{0.2772}} \times$$

$$\underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})^{0.7563}}\;\underset{(1926=100)}{(\text{price ratio})^{-0.0855}}$$

The average residual for the period 1919–32 is 1.8 percent, with the maximum of −5.1 percent occurring in 1922.

The average residual for the years of the extrapolated period, 1933–36, is 1.3 percent, the maximum of −2.2 percent occurring in 1935.

The amount of variation explained is 98 percent.

Summary No. 203a

Anthracite Coal—Manpower

Method used.—Total man-days in anthracite mining was related to the production of anthracite and a time trend. A major general strike occurred in the industry in 1922. In order that the analysis would not be dominated by the strike year it was decided to use the period beginning with 1924.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-days [1] (millions)	Production [1] (millions gross tons)
1924	43. 8	78. 5
1925	29. 2	55. 2
1926	40. 4	75. 4
1927	37. 2	71. 5
1928	34. 9	67. 3
1929	34. 1	65. 9
1930	31. 4	62. 0
1931	25. 2	53. 3
1932	19. 6	44. 5
1933	19. 0	44. 2
1934	22 6	51. 0
1935	19. 5	46. 6
1936	[2] 19. 2	[2] 48. 4

[1] Bureau of Mines, *Minerals Yearbooks* and *Mineral Resources of the United States,* for the respective years.

[2] Data not available at Bureau of Mines. Figure shown was obtained from the Pennsylvania Department of Mines at Harrisburg, Pennsylvania—excludes dredge operations but it is probably equal to the total within 1/371 percent.

The formula.—The following formula was derived from the data for the years of the period 1924–32:

$$\text{Calculated man-days} =$$

$$[238{,}900-3{,}971\,(\text{year}-1926)]\;\underset{\text{(Million gross tons)}}{(\text{production})^{1.1918}}$$

The average residual for the period 1924–32 is 1.5 percent, with the maximum of 3.0 percent occurring in 1930.

The man-days for the 4 years 1933–36 were extrapolated from the formula. The average residual for these 4 years is 2.0 percent, with the maximum of −5.0 percent occurring in 1936.

The amount of variation explained is 99 percent.

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[1] Federal Reserve Board. See table I of this Appendix.

[2] See table I of this Appendix.

[3] Ratio of average value, all bituminous coal f. o. b. mines (*Minerals Yearbooks*, Bureau of Mines) to Oklahoma prices at refineries of fuel oil (*Survey of Current Business*, 1936 supplement and monthly issues).

[4] Based on a weighted average of 3 series: (1) Pounds of coal per kilowatt-hour used for industrial purposes—as given in the *Statistical Abstract of the United States*, 1935, p. 339; (2) coal equivalent per ton of pig iron used in metallurgical industries—as given in the *Minerals Yearbook*, Bureau of Mines, 1936; (3) unit consumption of bituminous coal used in transportation based on *Statistics of Railways of the United States*, U. S. Interstate Commerce Commission, derived from an index of pounds of coal per thousand gross ton-miles in freight service and pounds of coal per passenger-train car-mile used in passenger service (weights are based on the average tons consumed in the respective services). The weights used in these 3 major groups of industries are 29, 18, and 26, respectively. These weights are in proportion to the coal consumed by these various classes of consumers as given by the Bureau of Mines for 1929.

[5] Calculated by Bureau of Mines and represents production plus imports minus exports plus or minus changes in consumer's stocks.

E. Estimated.

Summary No. 203b
Anthracite Coal—Consumption

Method used.—The consumption of anthracite coal was related to the consumer income, the ratio of the retail price of anthracite coal to a weighted average of the prices of domestic byproduct coke and of fuel oil, and a time trend. The Federal Reserve Board index of industrial production was also tried in conjunction with these factors. The coefficient so obtained turned out to be negative, a patent absurdity probably accounted for by the high intercorrelation with consumer income, and this factor was therefore omitted. A weighted average temperature was likewise tried, but no significant relationship was found. In 1922 and 1925 major strikes occurred in the industry, and for this reason data for these 2 years were omitted in deriving the relationship. An exponential formula was fitted to the data for the years of the period 1919–32, excluding the 2 strike years.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Consumption [1] (millions net tons)	Consumer income [2] (billions 1936 dollars)	Price ratio [3] (1926=100)
1919	81.5	46.6	104.6
1920	85.8	47.0	77.2
1921	82.0	42.3	93.4
1922	---	---	---
1923	86.9	54.8	84.9
1924	80.7	55.4	106.2
1925	---	---	---
1926	76.7	58.3	100.0
1927	74.7	58.9	106.4
1928	73.7	62.2	118.8
1929	71.5	65.3	117.1
1930	67.6	60.4	122.0
1931	58.4	54.6	130.7
1932	50.5	46.7	133.7
1933	49.6	48.2	127.5
1934	55.5	54.0	109.5
1935	50.0	56.9	105.2

[1] Calculated by Bureau of Mines, *Minerals Yearbooks*, for respective years.

[2] See table 1 of this Appendix.

[3] Based on ratio of retail price of anthracite coal to a weighted average of the prices of domestic byproduct coke and fuel oil. Price of domestic byproduct coke is average realization per ton as given by Bureau of Mines. Fuel oil prices represent prices at Oklahoma refineries as given in *Survey of Current Business*, 1936 supplement, p. 105. Weights used are: prices of domestic byproduct coke, 2; prices of fuel oils, 1.

The formula.—The following formula was obtained using the data for the years 1919–32 (omitting 1922 and 1925):

$$\underset{\text{(Millions of net tons)}}{\text{Calculated consumption}} =$$

$$22.33\ (0.9675)^{\text{year}-1926}\ \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income})^{0.60867}}\ \underset{(1926=100)}{(\text{price ratio})^{-0.26636}}$$

The average residual for the years 1919–32, omitting the years 1922 and 1925, is 2.2 percent, with the maximum of 6.6 percent occurring in 1921.

The average residual for the extrapolated years, 1933–35, is 1.3 percent, with the maximum of −3.7 percent occurring in 1933.

The amount of variation explained is 96 percent.

Summary No. 204a
Other Nonmetallic Mining—
Manpower

Method used.—The segment includes nonmetallic mining other than coal and petroleum and natural gas.

An index of man-hours was related to an index of production (based on value) for the years 1919–32 by an exponential formula.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (1929=100)	Production [2] (1929=100)
1919	104.6	56.0
1920	126.6	65.3
1921	87.4	58.0
1922	96.6	70.2
1923	108.2	80.2
1924	105.1	73.2
1925	119.0	82.5
1926	120.0	89.2
1927	112.4	91.4
1928	106.5	92.6
1929	100.0	100.0
1930	87.7	91.8
1931	62.1	75.3
1932	41.0	49.3
1933	48.9	63.3
1934	52.6	67.4
1935	56.0	77.4

[1] Bureau of Mines, *Metal Mine Accidents in the United States*, for the various years gives man-hours for 23 nonmetallic minerals for recent years and man-days for the entire period. Man-days were converted to man-hours on the basis of an estimated number of hours per day based on trends observed in metal mining underground operations.

[2] An index was compiled from output data for 14 minerals as given in the *Minerals Yearbook* and *Mineral Resources of the United States* for the various years published by the Bureau of Mines. The several series were weighted according to the value of the output in 1929.

The formula.—The following formula was derived from the data for the period 1919–32:

$$\underset{(1929=100)}{\text{Calculated man-hours}} =$$

$$0.7127\ \underset{(1929=100)}{(\text{production})^{1.12524}}\ (0.9391)^{\text{year}-1926}$$

The average residual for the years 1919–32 is 6.3 percent, with the maximum of −11.7 percent occurring in 1922.

The average residual for the extrapolated period, 1933–35, is 3.6 percent, with the maximum of 6.9 percent occurring in 1934.

The amount of variation explained is 93 percent.

Summary No. 204b
Other Nonmetallic Mining—
Consumption

Method used.—This segment includes the mining of all nonmetallic minerals except coal, crude petroleum, and natural gas.

Consumption of other nonmetallic minerals was related to the Federal Reserve Board index of manufacturing production and an index of construction activity for the period 1919–32 by an exponential formula. The points about the time trend partial regression indicated that a better fit would result if a straight line was used instead of an exponential, and this modification was therefore made.

The data.—The data used in the analysis are shown in the following table:

Consumption and related factors

Year	Consumption of nonmetallic minerals [1] (1929=100)	Index of manufacturing production [2] (1923–25=100)	Construction deflated value [3] (billions of 1929 dollars)
1919	51.1	84	3.06
1920	67.6	87	2.55
1921	46.1	67	2.89
1922	65.0	86	4.55
1923	76.7	101	4.33
1924	76.1	94	4.94
1925	87.3	105	6.65
1926	93.0	108	7.06
1927	88.8	106	6.93
1928	94.7	112	7.51
1929	100.0	119	6.44
1930	86.8	95	5.26
1931	66.7	80	3.86
1932	49.1	63	1.85
1933	60.7	75	1.76
1934	63.8	78	2.05
1935	74.5	90	2.42

[1] Bureau of Mines, *Minerals Yearbook* and *Mineral Resources of the United States*: includes quantity of 15 nonmetallic minerals weighted by 1929 values.

[2] Federal Reserve Board index of manufactures.

[3] See summary No. 500a, Construction—Manpower.

The formula.—The following formula was obtained using the data for the years of the period 1919–32:

$$\underset{(1929=100)}{\text{Calculated consumption}} =$$

$$0.3943\ \underset{(1923\text{–}25=100)}{(\text{index of manufacturing production})}^{1.13785} \times$$

$$\underset{(\text{Billions 1929 dollars})}{(\text{construction deflated value})}^{0.054885}\ [1.000 + .01137\ (\text{year} - 1925]$$

This formula gave excellent results. The average residual for the period 1919–32 is 2.8 percent, with the maximum of 7.3 percent occurring in 1920.

The average residual for the extrapolated period, 1933–35, is 1.6 percent with the maximum of −3.1 percent occurring in 1935.

The amount of variation explained is 96.5 percent.

Summary No. 205a
Iron Ore Mining—Manpower

Method used.—Manpower, measured in terms of man-hours, was related to output of merchantable ore in millions of tons for the period 1919–32 by an exponential formula.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours [1] (millions)	Production of merchantable ore [2] (millions of tons)
1919	125.1	61.0
1920	126.0	67.6
1921	59.4	29.5
1922	77.2	47.1
1923	107.6	69.4
1924	91.3	54.3
1925	86.3	61.9
1926	84.2	67.6
1927	82.0	61.7
1928	71.4	62.2
1929	77.1	73.0
1930	71.6	58.4
1931	40.9	31.1
1932	16.4	9.8
1933	17.9	17.6
1934	25.5	24.6
1935	26.3	30.5

[1] *Minerals Yearbooks* and *Mineral Resources of the United States* (Bureau of Mines) for the respective years. Data for 1919–22 estimated from a series of man-hours from *Metal Mine Accidents in the United States* (Bureau of Mines).

[2] *Minerals Yearbooks* and *Mineral Resources of the United States* (Bureau of Mines) for the respective years.

The formula.—The following formula was obtained using the data for the years of the period 1919–32:

$$\underset{(\text{Millions per year})}{\text{Calculated man-hours}} = 4.149\ (0.9515)^{\text{year}-1926}\ \underset{(\text{Millions of tons})}{(\text{production})}^{0.72917}$$

The average residual for the years 1919–32 is 5.0 percent, with the maximum of 8.6 percent occurring in 1930.

The average residual for the years of the extrapolated period, 1933–35, is 18.1 percent, with the maximum of 24.8 percent occurring in 1933.

The amount of variation explained is 98 percent.

Summary No. 205b
Iron Ore—Consumption

Method used.—The output of merchantable iron ore was related to the consumption of iron and steel for the period 1919–32 by an exponential formula. In a different analysis (see summary No. 137b) iron and steel consumption was related to industrial production, making a link between output of iron ore and the level of industrial production.

The data.—The following table gives the data used in the analysis:

Consumption and related factors

Year	Merchantable iron ore mined [1] (millions of gross tons)	Iron and steel available for domestic consumption [2] (millions of gross tons)
1919	61.0	29.3
1920	67.6	36.0
1921	29.5	16.7
1922	47.1	32.1
1923	69.4	41.5
1924	54.3	35.1
1925	61.9	42.4
1926	67.6	45.1
1927	61.7	41.2
1928	62.2	47.0
1929	73.0	51.3
1930	58.4	37.3
1931	31.1	24.1
1932	9.8	12.6
1933	17.6	21.4
1934	24.6	23.7
1935	30.5	31.7

[1] *Minerals Yearbooks* and *Mineral Resources of the United States* (Bureau of Mines) for the respective years.

[2] Derived by National Resources Committee from data published by the Federal Reserve Board and the American Iron and Steel Institute. See footnote 1 of summary No. 137b for iron and steel consumption.

The formula.—The formula obtained by using the data for the years of the period 1919–32 is as follows:

$$\underset{(\text{Millions of gross tons})}{\text{Calculated output of iron ore}} = 0.7137 \times$$

$$\underset{(\text{Millions of gross tons})}{(\text{iron and steel available for domestic consumption})}^{1.203896} \times$$

$$(0.9601)^{\text{year}-1926}$$

The average percent residual for the years 1919–32 is 8.9 percent, with the maximum of 23.7 percent occurring in 1930. This discrepancy is unusually large, the second largest being only 16.9 percent in 1932.

The average percent residual for the extrapolated years is 9.1 percent, with the maximum of −17.8 percent occurring in 1933. However, iron ore production and most raw materials subject to the principle of "derived demand" move violently so both the actual and the calculated values for 1932 and 1933 are very small. When the deviation is expressed as a percent of the average of the calculated figures for the entire period 1919–32, the largest residual is only 7.1 percent (in 1933 as before) and the average for the extrapolated period (1933–35) is only 3.9 percent of the average of all calculated values.

The amount of variation explained is 95 percent.

Summary No. 206a
All Nonferrous Metallic Mining—Manpower

Method used.—Man-hours in the mining of all nonferrous metals was related to the production of nonferrous metallic ores by a linear formula derived from graphically fitted regression lines for the period 1921–32. The graphical analysis indicated that a slightly better fit would result from the linear form than by the use of the usual exponential type of formula.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Man-hours in nonferrous metal mining [1] (millions)	Production of all nonferrous ores [2] (millions of dollars)
1921	104.0	264
1922	140.7	393
1923	169.7	519
1924	175.9	507
1925	188.1	537
1926	187.6	540
1927	166.9	526
1928	166.7	544
1929	179.2	587
1930	134.7	432
1931	97.4	299
1932	64.0	158
1933	63.3	142
1934	76.8	199

[1] U. S. Bureau of Mines. Lead, zinc, silver, and gold from *Minerals Yearbooks* and *Mineral Resources of the United States*. Copper derived from data in *Metal Mine Accidents in the United States* and above references. Man-hours in bauxite mine found to be insignificant.

[2] U. S. Bureau of Mines, *Minerals Yearbooks* and *Mineral Resources of the United States*. Value in current dollars. Includes lead, zinc, gold, silver, copper, and aluminum; see summary no. 206b.

The formula.—The following formula was obtained from the date for the years of the period 1921–32:

$$\underset{\text{(Millions)}}{\text{Calculated man-hours}} = 18.4 + .3042 \underset{\text{(Millions of dollars)}}{\text{(production)}} - 0.86667\ (\text{year} - 1926)$$

The average residual for the period 1921–32 is 4.5 percent, with the maximum of −8.2 percent occurring in 1928 and 1930.

The average residual for the extrapolated period, 1933–34, is 10.3 percent, with the maximum of 12.5 percent occurring in 1933.

The amount of variation explained is 94 percent.

Summary No. 206b
All Nonferrous Metallic Mining—
Consumption

Method used.—The consumption (expressed in value) of nonferrous metallic minerals was related to the value of production of refined nonferrous metals and a time trend. The data was fitted to a linear form because the graphical analysis indicated that a somewhat better fit would result than that given by the usual exponential form.

The following table gives the data used in the analysis for the years of the period 1919–32:

Consumption and related products

Year	Consumption [1] (millions of dollars)	Production of refined nonferrous metals [2] (millions of dollars)	Year	Consumption [1] (millions of dollars)	Production of refined nonferrous metals [2] (millions of dollars)
1919	399	580	1928	541	910
1920	421	560	1929	587	990
1921	264	360	1930	432	790
1922	393	480	1931	299	570
1923	519	710	1932	158	330
1924	507	760	1933	142	390
1925	537	790	1934	199	450
1926	540	850	1935	291	550
1927	526	860			

[1] Source: *Minerals Yearbooks*, and *Mineral Resources of the United States*, U. S. Bureau of Mines. Consumption was taken equal to production.

The value of the ores of aluminum, copper, zinc, lead, gold, and silver were added. Both underground and open cut copper are included. Value of copper is estimated on the basis of $5.08 per ton of ore. Value of zinc, lead, gold, and silver is based on the value of the smelted metals.

[2] Value of refined nonferrous metals produced is obtained by summing the following: production of refined copper from Summary No. 138.1a; and production of nonferrous metals other than copper from Summary No. 138a—includes lead, zinc, tin, and nickel. The copper series was valued at $360 per ton and the metals other than copper at $326 per ton, these values being taken as of 1929.

The formula.—The following formula was derived graphically from the data for the years of the period 1919–32:

$$\underset{\text{(Millions of dollars)}}{\left(\begin{array}{c}\text{Calculated consumption of}\\\text{nonferrous metallic ores}\end{array}\right)} = 22 + 0.60698 \times$$

$$\underset{\text{(Millions of dollars)}}{\left(\begin{array}{c}\text{value of production of}\\\text{refined nonferrous metals}\end{array}\right)} - 11.8594\ (\text{year} - 1926)$$

The average residual for the period 1919–32 is 4.5 percent, with the maximum of −12.7 percent occurring in 1919. The maximum residual for the extrapolated period, 1933–35, is 12.2 percent, with the maximum of −19.3 percent occurring in 1933. The residuals for the extrapolated period are not all in one direction; 1934 has a very small negative residual, while the 1935 residual is large and positive.

The amount of variation explained is 95 percent.

BULK DISTRIBUTION
AND
CONSTRUCTION

Summary No. 301a
Wholesale Trade—Manpower

Method used.—Employment in wholesale trade is related to an average of the Federal Reserve Board index of industrial production over the current and preceding year. The graphical analysis indicated that the best results would be obtained by the use of a linear relationship with no time trend.

The data.—The data used in the analysis are given in the following table:

Manpower and related factors

Year	Employment [1] (ten thousands)	Industrial production [2] (1923–25=100) 2-year average
1921	129	77
1922	131	76
1923	144	93
1924	145	98
1925	149	100
1926	149	106
1927	157	107
1928	160	108
1929	167	115
1930	158	108
1931	141	88
1932	125	72
1933	122	70
1934	133	78
1935	135	84
1936	154	98

[1] The employment series is the sum of entrepreneurs and employees. The number of employees for 1929–32 are Department of Commerce revised figures. For 1919–29 a wholesale employment series estimated from pay roll data was spliced to the Department of Commerce series. The estimated ratio of wholesale employment to total trade employment was applied to the total trade employment as given in unpublished data of the National Bureau of Economic Research. This ratio was estimated by taking the ratio of wholesale trade pay rolls to total trade pay rolls, and multiplying the series by the ratio of employment in 1929, and dividing by the 1929 ratio of pay rolls. The pay rolls data were obtained from the National Bureau of Economic Research. Entrepreneurs were obtained from the National Bureau of Economic Research for the years 1919 to 1928 and from Department of Commerce, 1929–36.

[2] 2-year average of current and previous year. See table I of the Appendix.

The formula.—The following formula was derived from the data for 1921–32:

$$\text{Calculated employment} = 611{,}100 + 8{,}899\ (\underset{(1923\text{–}25=100)}{\text{2-year average industrial production}})$$

The average residual for the years covered by the analysis, 1921–32, is 1.3 percent, with a maximum of −3.9 percent in 1926.

The average residual for the extrapolated years, 1933–36, is 2.0 percent, with a maximum of 4.1 percent in 1936.

The amount of variation explained is 95 percent.

Summary No. 302a
Business Service—Manpower

Method used.—The factors which are related to employment in business service are the consumer income of the current and of the previous year and a time trend.

The data.—The following table gives the data upon which the analysis was based:

Manpower and related factors

Year	Employment [1] (Thousands)	Consumer income [2] average of current and previous year (billions of 1936 dollars)
1920	148	46. 8
1921	130	44. 6
1922	136	45. 6
1923	160	51. 8
1924	180	55. 1
1925	196	56. 2
1926	215	57. 6
1927	219	58. 6
1928	236	60. 6
1929	260	63. 8
1930	254	62. 8
1931	234	57. 5
1932	208	50. 6
1933	209	47. 4
1934	237	51. 1
1935	252	55. 4
1936	262	60. 4

[1] Employment from 1929–36 based on the estimates of the U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce; from 1920–29, based on the estimates (unpublished) of the National Bureau of Economic Research. A comparable series was obtained by splicing the National Bureau series to the Department of Commerce series at 1929.

[2] See table I of this Appendix.

The formula.—The formula derived using the data for the years of the period 1920–32 is as follows:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 1.1635\ (1.026)^{\text{year}-1926}$$

$$(\underset{\text{(Billions 1936 dollars)}}{\text{average of consumer income of current and previous year}})^{1.2795}$$

The average residual for the years of the period, 1920–32, is 2.4 percent, with a maximum of 8.0 percent in 1920.

The average residual for the extrapolated period, 1933–36, is 6.4 percent, with a maximum of 8.7 percent occurring in 1934.

The percent of variation explained is 97 percent.

Summary No. 401a
Retail Trade—Manpower

Method used.—Employment is related to the consumer income by a linear relationship. No time trend was apparent. The analysis covered the years 1920–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment[1] (thousands)	Consumer income[2] (billions of 1936 dollars)
1920	4,300	47.0
1921	4,054	42.3
1922	4,328	48.8
1923	4,565	54.8
1924	4,767	55.4
1925	4,895	57.0
1926	5,089	58.3
1927	5,195	58.9
1928	5,210	62.2
1929	5,468	65.3
1930	5,332	60.4
1931	4,966	54.6
1932	4,532	46.7
1933	4,527	48.2
1934	4,859	54.0
1935	4,970	56.9
1936	5,208	63.9

[1] Employment: Employment is the sum of series on employees and entrepreneurs. For employees, the Department of Commerce series is used for 1929-36, and for 1919-28 a series obtained by deducting estimated wholesale trade employees (see summary No. 301a) from total trade employees as given by the National Bureau of Economic Research (unpublished data) is spliced to the Department of Commerce series. For entrepreneurs, National Bureau of Economic Research data for 1919–29 is adjusted and spliced to the Department of Commerce figures for 1929-36.

[2] See table 1 of this Appendix.

The formula.—The following formula was derived from the data for 1920–32:

$$\text{Calculated employment} = 1{,}420{,}000 + 62{,}181 \times \underset{\text{(Billions of 1936 dollars)}}{\text{(consumer income)}}$$

The average residual for the years covered by the anlaysis, 1920–32, is 2.2 percent, with a maximum of −5.6 percent in 1923.

The average residual for the extrapolated years, 1933–36, is 1.9 percent, with a maximum of −3.3 percent in 1936.

The amount of variation explained is 90 percent.

Summary No. 500a
Construction—Manpower

Method used.—The time available for this study was too short to allow the making of an adequate analysis of the factors relating to construction—hence inadequate and crude results have been obtained. A rough relationship between deflated value of construction output and real national income and real construction costs has been derived in order to arrive at the calculation of the manpower requirements in this segment.

Employment for all construction was related to a 3-year centered moving average of deflated value of building construction and time by means of a graphical analysis for the period 1920–32.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment in construction[1] (1929=100)	Deflated value of all construction[2] (billions of 1929 dollars)	Deflated value of all construction[3] (billions of 1929 dollars) 3-year moving average centered
1919	58.6	3.06	----------
1920	66.7	2.55	2.83
1921	60.4	2.89	3.33
1922	77.7	4.55	3.92
1923	90.4	4.33	4.61
1924	91.4	4.94	5.31
1925	90.6	6.65	6.22
1926	99.1	7.06	6.88
1927	94.6	6.93	7.17
1928	100.0	7.51	6.96
1929	100.0	6.44	6.40
1930	89.5	5.26	5.18
1931	64.6	3.86	3.05
1932	48.0	1.85	2.49
1933	43.5	1.76	1.89
1934	45.9	2.05	2.08
1935	46.6	2.42	2.65
1936	53.2	3.47	----------

[1] Data for 1919-28, National Bureau of Economic Research unpublished data adjusted to Department of Commerce data. Data for 1929-36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] *F. W. Dodge Corporation* reports cover 27 States for the years 1919-23; 36 in 1924, and 37 States for 1925-36. The correction for the missing 11 States was assumed to be 12 percent of the 37 States. Hence the later years were raised by 12 percent and all the earlier years were spliced on to the raised total. The resulting value series was deflated by the Interstate Commerce Commission index of construction costs from *Railroad Construction Indexes*, Bureau of Valuation, Interstate Commerce Commission, July 1, 1937 (mimeographed), and expressed in billions of 1929 dollars. The Interstate Commerce Commission cost series was used, even though the coverage of the items making up the cost series did not correspond exactly to the building construction items making up the value of construction, because this series is carefully constructed and its movements probably reflect general building costs rather closely.

Deflated value of construction was related to consumer income average of current and previous years and real construction costs obtained by deflating the Interstate Commerce Commission cost series by Bureau of Labor Statistics index of all commodity wholesale prices excluding farm products and foods. The formula found using the data for the years of the period 1929–36 was:

$$\underset{\text{(Billions of 1929 dollars)}}{\text{Calculated deflated value of construction}} =$$

$$3.5 + 0.3521\ \underset{\text{(Billions of 1936 dollars)}}{\text{(consumer income average current and previous year)}} -$$

$$0.1839\ \underset{(1926=100)}{\text{(construction costs)}} - 0.16185\ (\text{year} - 1926)$$

[3] 3-year moving average centered—based on the series of deflated output given in previous column.

The formula.—The formula obtained for the years of the period 1920–32 was:

$$\underset{(1929=100)}{\text{Calculated employment}} = -72.5 + 98.63 \times$$

$$\underset{\text{(Billions of 1929 dollars)}}{\text{(deflated value of construction, 3-year average)}}^{0.2904} -$$

$$0.8600\ (\text{year} - 1926) -$$

The average residual for the period fitted, 1920–32, is 4.9 percent, with the maximum of −15.6 percent occurring in 1921. This deviation is unusually large but the second largest is only 7.8 percent in 1930.

The average residual for the extrapolated period, 1933–35, is 7.9 percent, with the maximum of 8.2 percent occurring in 1923.

The amount of variation explained is 89.5 percent.

SERVICES TO THE CONSUMER

Summary No. 601a
Public Education—Manpower

Method used.—The factors which are related to employment in public education are consumer income and a time trend. It appears that the consumer income of the current year does not have any influence on employment, since the policy of most schools is to determine the employment for the current year at some date in the previous year. An average of the consumer income for the past 3 years was therefore used as one of the factors.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment[1] (thousands)	Consumer income average of past 3 years[2] (billions 1936 dollars)
1922	929	45.3
1923	955	46.0
1924	986	48.6
1925	1,028	53.0
1926	1,065	55.7
1927	1,092	56.9
1928	1,116	58.1
1929	1,134	59.8
1930	1,151	62.1
1931	1,164	62.6
1932	1,168	60.1
1933	1,155	53.9
1934	1,153	49.8
1935	1,152	49.6
1936	1,168	53.0

[1] Data for 1922–33, National Bureau of Economic Research unpublished data adjusted to Department of Commerce data. Data for 1934–36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] Based on table I of this Appendix.

The formula.—The following formula for employment was derived by using the data for the years of the period 1922–32.

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = .3972\,\underset{\text{(Billions of 1936 dollars)}}{\text{(consumer income, average past 3 years)}}^{0.2318} \times [1{,}298 - 196.36(0.9279)^{\text{year}-1929}]$$

The average residual for the period 1922–32 is 0.4 percent, with the maximum of 0.8 percent occurring in 1928.

The average residual for the extrapolated period 1933–36 is 0.4 percent, with the maximum of −1.0 percent occurring in 1936.

The amount of variation explained is 99 percent.

Summary No. 602a
Private Education—Manpower

Method used.—The factors related to employment in private education are consumer income average of the past 3 years, and a time trend. As in the case of public education, it appears that the current year consumer income has no influence on employment due to the fact that contracts are usually made in the previous year.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment[1] (thousands)	Consumer income average of past 3 years[2] (billions 1936 dollars)
1922	161	45.3
1923	168	46.0
1924	175	48.6
1925	181	53.0
1926	188	55.7
1927	197	56.9
1928	202	58.1
1929	204	59.8
1930	208	62.1
1931	210	62.6
1932	209	60.1
1933	204	53.9
1934	203	49.8
1935	207	49.6
1936	210	53.0

[1] Data for 1922–28, National Bureau of Economic Research unpublished data adjusted to Department of Commerce data; data for 1929–36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] Based on table 1 of this Appendix.

The formula.—The following formula for employment was derived by using the data for the years of the period 1922–32.

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = [0.967 + 0.01382\ (\text{year} - 1927)] \times [241 - 38992\ \underset{\text{(Billions of 1936 dollars)}}{\text{(consumer income average of past 3 years)}}^{-1.7007}]$$

The average residual for the period of the years 1922–32 is 0.9 percent, with the maximum of 2.0 percent occurring in 1928.

The average residual for the extrapolated period, 1933–36, is 1.1 percent, with the maximum of −1.4 percent occurring in 1933.

The amount of variation explained is 98 percent.

Summary No. 603a
Professional Service—Manpower

Method used.—The factors related to employment in professional service are consumer income, population of the United States, and a time trend. It appears that the consumer income of preceding years as well as the current year affects the variations in employment, and therefore the average of the current and the preceding 2 years of consumer income was used as one of the factors.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment [1] (thousands)	Consumer income, average current and 2 previous years [2] (billions 1936 dollars)	Population [3] (millions)
1921	856	45. 3	108
1922	902	46. 0	110
1923	967	48. 6	112
1924	1, 017	53. 0	113
1925	1, 032	55. 7	115
1926	1, 095	56. 9	116
1927	1, 125	58. 1	118
1928	1, 188	59. 8	120
1929	1, 248	62. 1	122
1930	1, 279	62. 6	123
1931	1, 278	60. 1	124
1932	1, 260	52. 9	125
1933	1, 263	49. 8	126
1934	1, 292	49. 7	127
1935	1, 337	53. 0	128
1936	1, 372	58. 3	128

[1] Data for 1921–28, National Bureau of Economic Research unpublished data adjusted to Department of Commerce data; 1929–36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] Based on the data in table I of this Appendix.

[3] See table I of this Appendix.

The formula.—The formula derived using the data for the years of the period 1921–32 is as follows:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = -1667.9 + 0.683\ (\text{year} - 1927) + 5.0028 \underset{\text{(Billions of 1936 dollars)}}{\begin{pmatrix}\text{consumer income, average of}\\ \text{current and preceding 2 years}\end{pmatrix}} + 21.3077\ \underset{\text{(Millions)}}{(\text{population})}$$

The average residual for the years of the period 1921–32 is 0.7 percent, with the maximum of −2.6 percent occurring in 1925.

The average residual for the extrapolated period, 1933–36, is 0.6 percent, with the maximum of 1.1 percent occurring in 1936.

The amount of variation explained is 99 percent.

Summary No. 604a
Personal Service—Manpower

Method used.—The factors related to employment are consumer income and a time trend. Since it appeared that consumer income of the previous year was also of importance, the factor employed was the average of the current and previous year consumer income.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment [1] (millions)	Consumer income, average current and previous year [2] (billions 1936 dollars)
1923	1. 20	51. 8
1924	1. 22	55. 1
1925	1. 27	56. 2
1926	1. 36	57. 6
1927	1. 43	58. 6
1928	1. 46	60. 6
1929	1. 62	63. 8
1930	1. 57	62. 8
1931	1. 45	57. 5
1932	1. 30	50. 6
1933	1. 25	47. 4
1934	1. 41	51. 1
1935	1. 49	55. 4
1936	1. 55	60. 4

[1] Data for 1920–28, National Bureau of Economic Research unpublished data adnsted to Department of Commerce data; data for 1929–36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] Based on table I of this Appendix.

The formula.—The following formula for employment was derived by using the data for the years of the period 1923–32:

$$\underset{\text{(Millions)}}{\text{Calculated employment}} = 0.02003\ (1.015)^{\text{year}-1928} \times \underset{\text{(Billions 1936 dollars)}}{(\text{consumer income, average of current and previous year})}^{1.0476}$$

The average residual for the period of the years 1923–32 is 1.6 percent, with the maximum of 3.4 percent occurring in 1923.

The average residual for the extrapolated period, 1933–36, is 3.3 percent, with the maximum of −6.6 percent occurring in 1936.

The amount of variation explained is 95 percent.

Summary No. 605a
Domestic Service—Manpower

Method used.—Employment in domestic service was related to consumer income of nonwage earners and a time trend. A multiplicative form of the equation was first used and the factors were introduced as exponentials. The time trend factor was then modified into a linear form.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment [1] (thousands)	Consumer income of other than wage earners [2] (billions 1936 dollars)
1919	1, 708	34. 7
1920	1, 706	34. 1
1921	1, 742	32. 4
1922	1, 841	37. 9
1923	1, 954	41. 2
1924	2, 003	42. 7
1925	2, 059	44. 3
1926	2, 130	45. 0
1927	2, 176	45. 8
1928	2, 184	49. 0
1929	2, 257	51. 4
1930	2, 108	48. 7
1931	1, 888	45. 3
1932	1, 621	39. 8
1933	1, 540	40. 7
1934	1, 740	41. 8
1935	1, 823	46. 9
1936	1, 954	52. 5

[1] 1919–28, unpublished data of National Bureau of Economic Research; 1929–36, Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] This is total consumer income less consumer income of wage earners. Consumer income of wage earners is computed from the wages of mining, manufacturing, transportation, and construction as estimated by the Department of Commerce, *Survey of Current Business*, June 1936, for the years 1929–36; from 1919–28 revised data of the National Bureau of Economic Research were used; this series was deflated by the Bureau of Labor Statistics Cost of Living Index (1936=100).

The formula.—The following formula was derived from the data for the years of the period 1919–32:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 45.39\,[1.00 - 0.02\ (\text{year} - 1926)] \underset{\text{(Billions 1936 doallrs)}}{\begin{pmatrix}\text{consumer income of}\\ \text{nonwage earners}\end{pmatrix}}^{1.6038}$$

The average residual for the period 1920–32 is 2.7 percent, with the maximum of 6.7 percent occurring in 1921.

The average residual for the extrapolated period, 1933–36, is 2.2 percent, with the maximum of −4.6 percent occurring in 1933.

The amount of variation explained is 90 percent.

Summary No. 606a Recreation and Amusement— Manpower

Method used.—Manpower in recreation and amusement was related directly to consumer income. A linear relationship was fitted to the data for the years 1927–32. This type of relationship appeared to give the best fit as indicated by the graphical analysis.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment[1] (thousands)	Consumer income[2] (billions of 1936 dollars)
1927	232	58.9
1928	245	62.2
1929	247	65.3
1930	246	60.4
1931	214	54.6
1932	182	46.7
1933	188	48.2
1934	212	54.0
1935	232	56.9
1936	252	63.9

[1] For the years 1929–36, the sum of the Department of Commerce figures for motion picture production and exhibition, radio broadcasting, and "other recreation and amusement," plus total entrepreneurs. For the years 1927–28, series from the National Bureau of Economic Research, spliced at 1929.

[2] See table I of this Appendix.

The formula.—The following formula was derived from the data for the years 1927–32:

$$\text{Calculated employment} = 7030 + 3803 \times \underset{\text{(Billions of 1936 dollars)}}{\text{(consumer income)}}$$

The average residual for the years covered by the analysis, 1927–32, is 1.6 percent with a maximum of 3.8 percent in 1930.

The average residual for the extrapolated years, 1933–36, is 1.4 percent, with a maximum of 4.0 percent in 1935.

The amount of variation explained is 94 percent.

Summary No. 607a Miscellaneous Consumers Service— Manpower

Method used.—The factors related to manpower are consumer income and a time trend. It appears that consumer income of the previous year was also related to the employment and therefore the average of the current and previous year's consumer income was used.

The data.—The following table gives the data used in the analysis:

Manpower and related factors

Year	Employment[1] (thousands)	Consumer income average current and previous year[2] (billions 1936 dollars)
1922	193	45.6
1923	212	51.8
1924	234	55.1
1925	255	56.2
1926	273	57.6
1927	287	58.6
1928	297	60.6
1929	311	63.8
1930	309	62.8
1931	293	57.5
1932	273	50.6
1933	271	47.4
1934	304	51.1
1935	324	55.4
1936	334	60.4

[1] Data for 1922–28, National Bureau of Economic Research unpublished data adjusted to Department of Commerce data; data for 1929–36 computed from data of Department of Commerce, Bureau of Foreign and Domestic Commerce.

[2] Based on table I of this Appendix.

The formula.—The formula derived, using the data for the years of the period 1922–32, is as follows:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 5.517\ (1.025)^{\text{year}-1927} \times$$

$$\underset{\text{(Billions 1936 dollars)}}{\text{(consumer income average current and previous year)}^{0.9605}}$$

The average residual for the years of the period 1922–32 is 2.3 percent, with the maximum of 4.4 percent occurring in 1927.

The average residual for the years of the extrapolated period 1933–36 is 4.3 percent, with the maximum of −6.2 percent occurring in 1936.

The amount of variation explained is 96 percent.

MISCELLANEOUS

Summary No. 800a
Miscellaneous Industries—Manpower

Method used.—This group of industries comprises all those for which individual data are not available. It includes persons engaged in the brokerage and building and loan fields, in fisheries and in hand trades, architects, artists, authors, chemists, designers, draftsmen, inventors, teachers of athletics and dancing, and persons engaged in various other difficult-to-classify industries and services.

Employment in this group was correlated with a 3-year average (current and past 2 years) of the Federal Reserve index of industrial production. An average was used because it probable that changes in employment in the various industries of this group occur very slowly and depend much more upon the trend of industrial production or buying power than upon the year to year fluctuations. The average of industrial production which has been used is highly correlated with buying power in the corresponding period.

The data.—The following table presents the data used in the analysis:

Manpower and related factors

Year	Persons engaged [1] (thousands)	F. R. B. industrial production, average current and past 2 years [2] (1923-25=100)
1921	1,978	79
1922	2,001	80
1923	2,064	84
1924	2,078	94
1925	2,148	100
1926	2,203	102
1927	2,266	106
1928	2,401	108
1929	2,390	112
1930	2,381	109
1931	2,287	99
1932	2,071	80
1933	2,077	74
1934	2,092	73
1935	2,029	82
1936	2,122	91

[1] Derived by subtracting the total of all the individual industrial segments (each one described elsewhere in this Appendix) from the total number of persons engaged in all industries. The total for all industries is unpublished data from the National Bureau of Economic Research adjusted to Department of Commerce data, 1921-28, and Department of Commerce data for 1929-36; the entire series adjusted upward in accordance with the augmented agriculture series (which includes unpaid family workers) used by National Resources Committee.

[2] Federal Reserve Board. 3-year average of data in table 1 of this Appendix.

The formula.—The following formula was obtained by graphical analysis of the data for the years of the period 1921–32:

$$\underset{\text{(Thousands)}}{\text{Calculated employment}} = 1940+270\left(\frac{\text{industrial production, average of 3 years}}{100}\right)^{4.577}$$

The average residual for the years of the period covered, 1921–32, is 2.0 percent, with the maximum of 4.0 percent occurring in 1931.

The average residual for the years of the extrapolated period, 1933–36, is 2.3 percent, with the maximum of 4.4 percent occurring in 1934.

The amount of variation explained is 87 percent.

Summary No. 801a
Nonwage Earners in Mining and Manufacturing

Method used.—The nonwage earners segment is made up of salaried workers (including central administrative office employees), and entrepreneurs in all manufacturing industries and in mining and quarrying. The total was related to the average of the industrial production for the current year and previous year, since this group of workers is affected by the past activity as well as by the current. The data for the years 1919 and 1920 were omitted from the analysis since they tend to distort the relationship; this is due to the influence of other important factors at work during those years.

The data.—The following table gives the data used in the analysis:

Nonwage earners in mining and manufacturing and related factors

Year	Nonwage earners[1] (thousands)	Average industrial production, current year and previous year [2] (1923-25=100)
1921	1,250	77
1922	1,326	76
1923	1,490	93
1924	1,462	98
1925	1,470	99
1926	1,545	106
1927	1,576	107
1928	1,586	108
1929	1,733	115
1930	1,719	107
1931	1,514	88
1932	1,282	72
1933	1,213	68
1934	1,368	78
1935	1,386	84
1936	1,470	98

[1] Based upon unpublished data of the National Bureau of Economic Research, 1921-28, and data from the Department of Commerce, Bureau of Foreign and Domestic Commerce, 1929-36. The series includes central administrative office employees.

[2] Based on the Federal Reserve Board's index of industrial production (1923-25=100). See table I of this Appendix.

The formula.—The following formula was derived from the data for the years of the period, 1921–32:

$$\underset{\text{(Thousands)}}{\text{Calculated nonwage earners}} = 11.05\left(\underset{\text{(1923-25=100)}}{\begin{matrix}\text{average of industrial production,}\\ \text{current and previous year}\end{matrix}}\right)+446$$

The average residual for the years 1921–32 is 3.6 percent, with the maximum of 6.3 percent occurring in 1931.

The values for the 4 years 1933–36 were extrapolated by the use of the formula. The average residual for these 4 years is 2.3 percent, with the maximum of −4.6 percent occurring in 1936.

The amount of variation explained is 97.5 percent.

Summary No. 1000b
Value of Imports

Method used.—The value of imports in current dollars is related to the consumer income in current dollars, an index of the value of industrial production, and a time trend. An exponential relationship is fitted to the data for the years 1919–32.

The data.—The following table gives the data used in the analysis:

Value of imports and related factors

Year	Value of imports[1] (millions current dollars)	Consumer income,[2] (billions current dollars)	Value of industrial productions[3] (1926=100)
1919	3, 828	57. 3	99. 0
1920	5, 102	66. 8	130. 0
1921	2, 557	53. 9	65. 0
1922	3, 074	57. 9	80. 6
1923	3, 732	66. 5	97. 5
1924	3, 575	67. 3	87. 7
1925	4, 176	70. 9	98. 8
1926	4, 406	73. 3	100. 0
1927	4, 163	73. 2	92. 2
1928	4, 078	75. 8	95. 5
1929	4, 339	79. 3	100. 1
1930	3, 114	71. 9	75. 7
1931	2, 088	59. 4	56. 2
1932	1, 325	45. 9	41. 6
1933	1, 433	44. 6	50. 1
1934	1, 636	51. 8	57. 3
1935	2, 039	55. 9	64. 9
1936	2, 600	63. 9	77. 4

The formula.—The following formula was derived from the data for the years of the period 1919–32:

$$\text{Value of imports} = \$2{,}792{,}000\ (0.9848)^{\text{year}-1926} \times$$

$$\underset{\text{(Billions current dollars)}}{(\text{consumer income})}^{0.91288}\ \underset{(1926=100)}{(\text{value of industrial production})}^{0.73914}$$

The average residual for the years of the period 1919–32, is 2.3 percent, with the maximum of −7.0 percent occurring in 1923.

The average residual for the extrapolated years, 1933–35, is 2.1 percent with the maximum of −4.8 percent occurring in 1934.

The amount of variation explained is 98 percent.

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[1] U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, as given in the *Surrey of Current Business.*

[2] See table I of this Appendix.

[3] The Federal Reserve Board index of industrial production (see table I) was reduced to a 1926=100 base and multiplied by the Bureau of Labor Statistics wholesale price index excluding farm products and food.

TABLE II.—*Number of wage earners in manufacturing segments* [1]

Code No.	Segment	1919	1920	1921	1922	1923	1924	1925	1926	1927
	Food, tobacco, and leather:									
101a	Butter, cheese, condensed milk and ice cream	54, 468	(2)	51, 675	(2)	56, 020	54, 329	51, 317	(2)	62, 933
102a	Meat packing	160, 996	141, 651	117, 042	116, 184	132, 792	127, 080	120, 422	118, 084	119, 095
103a	Flour milling	45, 481	40, 933	35, 378	35, 884	35, 191	33, 400	31, 988	30, 753	29, 982
104a	Canning and preserving	89, 923	(2)	59, 675	(2)	81, 678	72, 618	96, 396	(2)	93, 574
105a	Tobacco	157, 097	154, 039	149, 985	146, 427	146, 337	136, 739	132, 132	125, 806	129, 299
106. 1a	Sugar refining	36, 084	35, 558	31, 783	33, 664	25, 645	25, 046	25, 440	23, 399	22, 369
107a	Leather (tanning and finishing)	72, 476	64, 082	48, 955	57, 485	59, 703	52, 184	52, 263	52, 895	52, 924
108a	Bread and other bakery products	141, 592	155, 417	148, 500	149, 895	162, 613	164, 186	160, 411	164, 674	171, 995
109a	Other Foods	143, 194	127, 070	105, 484	106, 974	108, 254	108, 094	107, 728	105, 754	105, 741
110a	Confectionery and chocolate	85, 576	(2)	67, 656	(2)	70, 361	66, 900	70, 728	73, 149	69, 590
111a	Boots and shoes	211, 049	196, 467	183, 502	202, 904	225, 216	205, 584	206, 992	203, 246	203, 110
112a	Leather products other than leather and boots and shoes.	66, 554	58, 099	47, 906	64, 377	59, 826	53, 762	54, 873	56, 360	60, 047
	Textiles:									
113a	Woolen and worsted	166, 787	(2)	162, 364	(2)	194, 552	174, 360	165, 224	149, 782	154, 361
114a	Cotton textiles	430, 966	481, 639	412, 058	414, 408	471, 503	408, 665	445, 184	450, 194	467, 596
115a	Silk and rayon	126, 782	131, 356	121, 378	119, 666	125, 234	119, 164	132, 509	129, 345	127, 643
116a	Rayon yarn	(2)	(2)	(2)	(2)	13, 968	14, 896	19, 128	(2)	26, 341
118a	Knit goods	172, 572	179, 088	161, 880	193, 349	194, 244	175, 014	186, 668	187, 608	190, 283
119a	Wearing apparel	507, 700	519. 037	473, 574	485, 887	499, 413	455, 406	466, 846	473, 092	501, 656
120a	Dyeing and finishing	55, 985	53, 127	51, 510	54, 881	63, 414	61, 129	70, 749	72, 131	73, 851
120. 1a	Other textiles	149, 211	143, 566	126, 974	142. 687	166, 933	152, 563	161, 103	166, 033	179, 026
	Paper and printing:									
121a	Paper and pulp	113, 759	130, 972	105, 294	109, 384	120, 677	117, 344	123, 842	127, 595	123, 360
123a	Converted paper products	94, 356	101, 693	79, 462	93, 333	98, 349	96, 975	97, 660	100, 802	101, 077
126a	Printing and publishing (newspaper and periodical)	120, 381	110, 587	107, 534	111, 055	116, 646	118, 069	117, 601	118, 887	119, 399
126. 1a	Printing and publishing (books, music, and job)	124, 307	148, 507	122, 771	125, 454	131, 738	134, 970	135, 514	140, 599	143, 341
126. 2a	Printing and publishing (allied industries)	57, 246	58, 838	52, 195	55, 917	60, 609	62, 591	62, 749	64, 684	65, 863
	Forest products:									
122a	Lumber and millwork	567, 901	528, 779	451, 932	574, 940	598, 712	577, 980	578, 309	566, 344	510, 977
124a	Furniture and related products	147, 061	161, 258	129, 133	153, 013	173, 529	169, 856	186, 283	194, 485	193, 787
125a	Miscellaneous lumber products	139, 527	120, 257	111, 952	153, 419	146, 378	141, 951	142, 687	147, 798	146, 288
	Rubber:									
127a	Rubber tires and tubes	158, 549	(2)	55, 496	(2)	73, 963	71, 536	81, 640	79, 788	78, 256
128a	Rubber products other than tires and tubes		(2)	47, 777	61, 861	63, 905	51, 751	60, 229	61, 361	63, 741
	Chemicals:									
129a	Chemicals	243, 837	(2)	165, 254	(2)	206, 518	163, 075	184, 122	188, 855	183, 565
129. 1a	Paints and varnishes	21, 507	(3)	18, 015	19, 425	22, 818	23, 310	25, 490	25, 647	28, 061
135a	Fertilizer	26, 296	26, 639	16, 898	17, 724	18, 572	17, 224	19, 644	20, 868	18, 612
	Products of minerals other than metals:									
131a	Petroleum refining	58, 889	(2)	63, 189	(2)	66, 717	62, 273	65, 324	71, 798	71, 234
132a	Glass	77, 520	83, 531	54, 748	68, 000	73, 335	66, 717	69, 371	72, 456	65, 825
133a	Cement	25, 524	30, 738	26, 231	33, 173	35, 091	37, 269	38, 437	37, 675	36, 322
134a	Clay products other than pottery	77, 763	(2)	69, 171	(2)	103, 239	100, 773	103, 061	105, 061	101, 230
134. 1a	Pottery	27, 934	29, 920	28, 458	32, 538	36, 824	38, 821	36, 536	37, 288	36, 667
134. 2a	Marble granite and other glass products	92, 902	(2)	71, 394	(2)	103, 136	102, 867	105, 584	111, 131	109, 959
136a	Coke	29, 490	28, 632	16, 441	21, 896	28, 728	23, 042	23, 437	23, 551	21, 356
	Metals and metal manufactures:									
137a	Iron and steel	416, 784	(2)	254, 213	(2)	421, 913	394, 614	399, 914	410, 464	389, 270
138a	Nonferrous metals other than copper	25, 086	(2)	12, 706	(2)	20, 857	21, 225	21, 606	(2)	20, 163
138. 1a	Copper smelting and refining	17, 315	(2)	8, 293	(2)	16, 777	16, 235	15, 588	(2)	13, 924
139a	Iron and steel products	441, 016	(2)	317, 213	(2)	467, 272	438, 713	450, 869	470, 114	445, 697
140a	Nonferrous metal products	262, 337	(2)	191, 681	(2)	260, 164	243, 500	239, 422	245, 300	238, 580
141a	Automobiles	343, 115	354, 779	212, 777	289, 541	404, 886	376, 927	426, 110	422, 030	369, 399
143a	Transportation equipment other than autos	515, 467	(2)	192, 996	(2)	201, 442	147, 691	133, 468	136, 398	125, 506
144a	Electrical machinery	212, 374	(2)	161, 204	(2)	229, 070	217, 730	220, 436	215, 000	211, 600
145a	Machinery excluding electrical	805, 801	(2)	518, 125	(2)	695, 052	603, 788	641, 580	(2)	664, 604
146a	Miscellaneous manufacturing industries	309, 911	326, 000	256, 257	274, 000	303, 062	310, 034	307, 931	320, 000	319, 521
	Grand total	8, 428, 442	8, 512, 000	6, 476, 089	7, 133, 000	8, 194, 879	7, 610, 000	7, 871, 945	8, 028, 000	7, 848, 600

Code No.	Segment	1928	1929	1930	1931	1932	1933	1934	1935	1936
	Food, tobacco, and leather:									
101a	Butter, cheese, condensed milk, and ice cream	(2)	51, 962	(2)	42, 571	39, 288	40, 337	47, 453	48, 544	50, 018
102a	Meat packing	120, 112	122, 505	116, 691	106, 707	102, 120	113, 193	138, 888	116, 620	(2)
103a	Flour milling	28, 642	27, 028	24, 756	22, 840	22, 010	23, 207	26, 595	26, 495	25, 736
104a	Canning and preserving	(2)	112, 478	116, 037	88, 775	71, 980	94, 267	120, 379	129, 633	122, 200
105a	Tobacco	125, 529	116, 119	108, 367	99, 769	90, 790	87, 325	94, 600	90, 442	90, 000
106. 1a	Sugar refining	21, 599	23, 727	23, 172	20, 128	20, 383	24, 572	24. 703	26, 008	(2)
107a	Leather (tanning and finishing)	51, 582	49, 832	46, 276	42, 047	37. 634	44, 191	49, 008	50, 877	51, 262
108a	Bread and other bakery products	182, 213	200, 841	197, 316	183, 161	173, 443	182, 382	212, 110	218, 423	231, 625
109a	Other foods	115, 000	129, 640	127, 466	114, 238	107, 014	131, 210	166, 974	171, 319	177, 332
110a	Confectionery and chocolate	67, 947	69, 750	63, 562	56, 939	52, 323	57, 069	59, 051	60, 400	60, 040
111a	Boots and shoes	197, 080	205, 640	191, 765	181, 374	179, 647	190, 915	202, 178	202, 113	(2)
112a	Leather products other than leather and boots and shoes	60, 604	63, 000	56, 991	49, 336	45, 401	46, 894	53, 327	57, 765	(2)
	Textiles:									
113a	Woolen and worsted	148, 001	146, 959	119, 683	119, 537	99, 736	127, 227	119, 339	158, 467	(2)
114a	Cotton textiles	421, 919	424, 916	356, 533	329, 962	296, 448	379, 445	393, 674	369, 061	(2)
115a	Silk and rayon	126, 957	130, 467	119, 541	109, 225	93, 018	110, 322	119, 699	125, 908	(2)
116a	Rayon yarn	(2)	39, 106	38, 752	38, 735	34, 288	44, 306	46, 654	50, 550	52, 281
118a	Knit goods	190, 015	208, 488	190, 571	178, 011	174, 273	189, 698	205, 253	219, 776	230, 483
119a	Wearing apparel	513, 165	536, 561	497, 262	472, 168	422, 053	462, 857	518, 862	573, 806	635, 503
120a	Dyeing and finishing	74, 800	79, 327	73, 058	67, 603	60, 534	66, 272	72, 940	74, 749	(2)
120. 1a	Other textiles	174, 962	181, 080	157, 065	144, 302	123, 241	138, 504	152, 448	165, 970	175, 211
	Paper and printing:									
121a	Paper and pulp	121, 565	128, 049	123, 615	107, 902	98, 771	107, 298	123, 822	126, 971	128, 865
123a	Converted paper products	102, 102	105, 344	99. 501	89, 186	83, 689	89, 082	103, 780	108, 694	(2)
126a	(Printing and publishing (newspaper and periodical)	122, 160	129, 660	128, 473	119, 503	108, 600	109, 087	116, 505	118, 684	124, 796
126. 1a	Printing and publishing (books, music, and job)	143, 950	151, 459	149, 084	135, 977	114, 442	104, 699	118, 414	126, 692	138, 726
126. 2a	Printing and publishing (allied industries)	69, 518	70, 869	71, 409	62, 308	53, 293	50, 320	56, 126	59, 466	64, 762

[1] Census of Manufactures data in odd years, interpolated in even years by Bureau of Labor Statistics employment indexes (adjusted to 1935 census data by method roughly similar to that used by Bureau of Labor Statistics in adjusting to 1933 census).

[2] Not available.

TABLE II.—*Number of wage earners in manufacturing segments*—Continued

Code No.	Segment	1928	1929	1930	1931	1932	1933	1934	1935	1936
	Forest products:									
122a	Lumber and millwork	496, 190	509, 743	392, 052	251, 086	188, 959	224, 844	271, 504	303, 527	360, 058
124a	Furniture and related products	190, 018	199, 235	158, 513	131, 310	102, 083	108, 298	115, 337	133, 772	157, 465
125a	Miscellaneous lumber products	148, 557	153, 861	135, 557	123, 900	102, 373	116, 303	126, 425	136, 638	148, 105
	Rubber:									
127a	Rubber tires and tubes	83, 194	83, 263	59, 803	49, 159	45, 269	52, 926	60, 340	57, 128	58, 909
128a	Rubber products other than tires and tubes	66, 013	65, 885	55, 561	50, 100	45, 418	53, 307	58, 272	57, 553	62, 572
	Chemicals:									
129a	Chemicals	184, 699	196, 292	183, 190	160, 047	145, 978	163, 751	191, 589	187, 733	194, 536
129. 1a	Paints and varnishes	28, 335	29, 211	25, 268	22, 521	20, 857	22, 880	26, 319	27, 686	28, 646
135a	Fertilizer	19, 906	20, 926	20, 535	14, 551	10, 452	13, 063	17, 661	17, 473	15, 989
	Products of minerals other than metals:									
131a	Petroleum refining	67, 846	80, 596	80, 935	68, 824	63, 958	69, 047	77, 609	77, 402	78, 783
132a	Glass	64, 691	67, 527	58, 546	49, 917	41, 597	49, 797	63, 880	67, 138	68, 548
133a	Cement	34, 169	33, 368	31, 217	24, 317	16, 900	15, 829	19, 850	20, 698	23, 791
134a	Clay products other than pottery	94, 238	93, 657	73, 716	51, 128	32, 468	31, 944	39, 130	44, 583	61, 177
134. 1a	Pottery	36, 951	35, 409	31, 005	27, 023	21, 916	23, 632	27, 838	28, 845	28, 374
134. 2a	Marble granite and other glass products	105, 188	98, 456	86, 457	70, 486	50, 709	51, 828	65, 042	71, 957	(2)
136a	Coke	18, 994	20, 978	18, 674	14, 684	11, 444	13, 362	15, 820	17, 035	18, 266
	Metals and metal manufactures:									
137a	Iron and steel	390, 957	419, 534	366, 979	278, 206	234, 899	288, 945	347, 601	374, 808	424, 171
138a	Nonferrous metals other than copper	(2)	21, 502	(2)	13, 264	11, 144	12, 640	15, 471	16, 793	17, 759
138. 1a	Copper smelting and refining	(2)	14, 544	(2)	8, 642	5, 993	5, 596	8, 363	10, 449	11, 856
139a	Iron and steel products	438, 934	461, 348	399, 338	319, 747	250, 493	265, 163	321, 761	351, 083	455, 753
140a	Nonferrous metal products	252, 900	278, 695	233, 600	186, 683	152, 000	170, 036	208, 700	237, 758	141, 900
141a	Automobiles	435, 319	447, 448	323, 368	285, 515	243, 634	243, 614	351, 779	387, 801	397, 108
143a	Transportation equipment other than autos	106, 768	135, 907	128, 559	88, 244	69, 108	63, 759	89, 609	93, 088	112, 516
144a	Electrical machinery	247, 300	283, 015	238, 190	180, 106	134, 774	130, 857	161, 240	179, 641	203, 274
145a	Machinery excluding electrical	(2)	786, 255	661, 925	486, 633	349, 626	374, 452	504, 012	576, 555	680, 379
146a	Miscellaneous manufacturing industries	310, 000	322, 290	274, 000	225, 766	187, 529	207, 009	244, 075	249, 217	(2)
	Grand total	7, 822, 000	8, 369, 752	7, 289, 000	6, 163, 144	5, 244, 000	5, 787, 611	6, 771, 000	7, 203, 794	7, 670, 000

[1] Not available.

Persons engaged in nonmanufacturing industries, and nonwage earners in manufacturing

[Equivalent full-time employment, in thousands]

Code No.	Segment	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
	Services to the economy:																		
1	Federal Government, exclusive of Post Office	1, 620	809	748	592	562	565	563	550	549	560	590	590	599	587	586	677	790	900
2	State and local government	958	985	959	972	1, 018	1, 081	1, 086	1, 124	1, 100	1, 210	1, 237	1, 278	1, 251	1, 237	1, 187	1, 208	1, 241	1, 293
3	Banking and finance	732	782	793	764	819	877	904	982	1, 051	1, 113	1, 185	1, 150	1, 095	1, 044	996	1, 041	1, 097	1, 123
4	Post Office	236	245	252	250	256	264	271	275	277	279	282	283	282	278	270	264	260	267
6	Telephone	274	298	286	305	333	340	352	360	367	383	427	419	369	334	308	299	292	300
6	Telegraph	76	77	73	70	74	76	82	86	83	86	96	94	81	68	66	72	70	74
7	Electric power	105	119	123	136	178	192	198	225	235	251	272	280	260	226	214	228	230	246
8	Gas	63	57	54	59	66	69	71	73	75	72	65	60	53	45	48	50	51	54
9	Rail transportation	2, 135	2, 268	1, 865	1, 820	2, 060	1, 952	1, 944	1, 982	1, 932	1, 843	1, 846	1, 659	1, 406	1, 155	1, 084	1, 123	1, 113	1, 200
10	Auto transportation	----	----	----	----	----	----	----	----	----	----	741	749	722	677	667	708	755	834
11	Other transportation	633	712	627	658	661	642	621	630	612	598	590	557	494	435	419	441	447	470
	Services to the consumer:																		
601	Public education	831	854	895	929	955	986	1, 028	1, 065	1, 092	1, 116	1, 134	1, 151	1, 164	1, 168	1, 155	1, 153	1, 152	1, 168
602	Private education	135	145	154	163	171	178	183	191	200	205	207	208	209	207	204	203	207	210
603	Professional service	852	839	856	902	967	1, 017	1, 032	1, 095	1, 125	1, 188	1, 248	1, 279	1, 278	1, 260	1, 263	1, 292	1, 337	1, 372
604	Personal service	1, 049	1, 042	1, 056	1, 127	1, 198	1, 221	1, 266	1, 355	1, 426	1, 463	1, 617	1, 571	1, 450	1, 296	1, 249	1, 406	1, 488	1, 654
605	Domestic service	1, 708	1, 706	1, 742	1, 841	1, 954	2, 003	2, 059	2, 130	2, 176	2, 184	2, 257	2, 108	1, 888	1, 621	1, 540	1, 740	1, 823	1, 954
606	Recreation and amusement	142	174	177	157	184	188	181	208	232	245	247	246	214	182	188	212	232	252
607	Miscellaneous service	140	168	180	193	212	234	255	273	286	297	311	309	292	273	271	304	324	334
	Minerals (wage-earners only):																		
201	Petroleum	124	146	106	128	130	117	132	160	139	108	140	119	82	76	90	113	109	106
204	Nonmetallic	77	94	74	85	104	103	104	104	103	100	96	81	65	47	43	47	44	48
202	Bituminous coal	548	631	440	432	553	461	495	546	482	446	460	430	383	310	312	355	353	364
203	Anthracite	148	140	161	97	151	160	103	155	159	152	147	137	118	92	76	87	78	74
205 206	Iron ore Other metallic	138	136	73	98	124	122	126	126	115	112	120	106	81	53	53	67	80	102
	Bulk distribution:																		
301	Wholesale trade	1, 468	1, 524	1, 287	1, 308	1, 442	1, 454	1, 490	1, 485	1, 572	1, 602	1, 671	1, 581	1, 408	1, 252	1, 225	1, 328	1, 350	1, 536
302	Business service	148	148	130	136	160	180	196	215	219	236	260	254	234	208	209	237	252	262
401	Retail trade	3, 897	4, 300	4, 054	4, 328	4, 565	4, 767	4, 895	5, 089	5, 195	5, 210	5, 468	5, 332	4, 966	4, 532	4, 527	4, 859	4, 970	5, 208
500	Construction	904	1, 029	932	1, 198	1, 395	1, 409	1, 398	1, 528	1, 460	1, 542	1, 543	1, 381	996	740	672	709	719	820
800	Miscellaneous industries	1, 859	1, 921	1, 978	2, 001	2, 064	2, 078	2, 148	2, 203	2, 266	2, 404	2, 390	2, 381	2, 287	2, 071	2, 077	2, 092	2, 030	2, 122
801	Nonwage earners:																		
	Manufacturing	1, 500	1, 490	1, 179	1, 246	1, 394	1, 372	1, 377	1, 440	1, 477	1, 496	1, 629	1, 615	1, 425	1, 208	1, 136	1, 283	1, 305	1, 387
	Mining	88	102	71	80	96	90	93	105	99	90	104	104	89	74	77	85	81	83
900	Agriculture	10, 338	10, 374	10, 264	10, 209	10, 142	10, 030	10, 040	9, 965	9, 921	9, 919	9, 888	9, 750	9, 719	9, 612	9, 875	9, 875	9, 925	10, 125

Source: U. S. Department of Commerce data and unpublished material of the National Bureau of Economic Research.